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Technical Report 663

AD-A168 290

Media/Device Configurations for Platoon Leader Tactical Training

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U. S. Army
Research Institute for the Behavioral and Social Sciences

February 1985

U. S. ARMY RESEARCH INSTITUTE

FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency under the Jurisdiction of the

Deputy Chief of Staff for Personnel

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NOTICES

REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: ARI Technical Report 663	2. GOVT ACCESSION NO.: AD-A168290
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): MEDIA/DEVICE CONFIGURATIONS FOR PLATOON LEADER TACTICAL TRAINING	5. TYPE OF REPORT & PERIOD COVERED: Final Report October 1982 - January 1984
	6. PERFORMING ORG. REPORT NUMBER: --
7. AUTHOR(s): Kerm Henriksen, Donald R. Jones, Lisa C. Sergent, & Billy E. Rutherford	8. CONTRACT OR GRANT NUMBER(s): MDA 903-82-C-0515
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Allen Corporation of America, 401 Wythe Street, Alexandria, VA 22314	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 2Q263743A794 Task 3222, WU 100
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Research Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue, Alexandria, VA 22333-5600	12. REPORT DATE: February 1985
	13. NUMBER OF PAGES: 504
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office): USARI Fort Knox Field Unit, Steele Hall, Fort Knox, KY 40121	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: --

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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18. SUPPLEMENTARY NOTES

This research was technically monitored by Dr. David W. Bessemer, USARI Fort Knox Field Unit.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Advanced training technology	Tactical scenarios
Computer-based devices	Media/device combinations
Microcomputer-based devices	Tactical training
Armor platoon leader training	Training device

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of the research effort was to define and conceptualize media/device combinations which have potential to support effective training on tactical leadership tasks for armor platoon leaders. Critical tasks were selected from platoon operations for development of offensive and defensive scenarios. Each scenario was examined for platoon leader actions and associated events for the specification of functional capability requirements. Concurrently, information was gathered on a wide range of technological options. The technological options were organized into generic (Continued)

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20. (Continued)

subsystem conceptualizations from which compatible media/device configurations were identified. The configurations were rank ordered with respect to functional capability and other evaluation criteria, serving to identify those with the greatest potential for supporting training on specific tactical tasks. The highest rankings went to the multiple processor devices that offer a dedicated graphics capability. Such devices provide sufficient display power to represent appropriate battlefield conditions, allow for adequate computing power, thus minimizing software development costs, and derive added design and development flexibility through the availability of mature, supporting software packages.

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Office, Deputy Chief of Staff for Personnel
Department of the Army

February 1985

Army Project Number
2Q263743A794

Education and Training

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FOREWORD

The Training Research Laboratory of the Army Research Institute for the Behavioral and Social Sciences (ARI) performs research and development in areas that can help the Army meet its training mandate more effectively. Because of the high resource costs associated with the conduct of tactical training in field settings, ARI is especially interested in the use of low-cost microcomputer technology for the purpose of teaching well-defined tactical leadership tasks. This report identifies a number of media/device configurations and evaluates the extent to which they could be used for training critical armor platoon leader tactical tasks.

In addition to an identification of potential media/device configurations, this report contains a set of tactical scenarios useful to researchers and training developers in need of contextual material. Also, functional descriptions of the identified technological options may serve as a useful primer for individuals wishing to learn more about computer-based training technology.

Edgar M. Johnson

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Technical Director

MEDIA/DEVICE CONFIGURATIONS FOR PLATOON LEADER TACTICAL TRAINING

EXECUTIVE SUMMARY

Requirement:

The purpose of the research is to identify and evaluate media/device configurations which have potential to support effective training on armor platoon leader tactical tasks.

Procedure:

Critical platoon leader tasks were first identified from previous ARI-sponsored research. From these tasks, tactical scenarios were written to arrive at a set of functional capability requirements that potential media/device configurations should adequately address. The method for conceptualizing potential media/device configurations was to initially collect information on a wide range of technological options, organize the options into subsystems, and then devise a representative set of media/device configurations based on compatible subsystem options. The potential devices were then evaluated on how well they could be expected to fulfill functional capability requirements. An overall rank order was established for the potential devices. Finally, the potential devices were classified on the basis of software development categories.

Findings:

Altogether, twenty potential devices were defined, ranging from conventional audio-visual combinations to state-of-the-art multiple microprocessors. With respect to the ranking procedure, the multiple processor devices occupied the top ranks, followed generally by the 16-bit, audio-visual, 8-bit, and dedicated bus devices in descending order. The greatest amount of required software development was projected for the less capable microprocessor-based devices.

Utilization of Findings:

The findings should serve as an aid to those involved in the procurement of training devices designed to support tactical training in institutions and units.

MEDIA/DEVICE CONFIGURATIONS FOR PLATOON LEADER TACTICAL TRAINING

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INTRODUCTION

The primary purpose of the present effort is to define and conceptualize media/device combinations which have potential to support effective training on tactical leadership tasks. The overall focus will be on a broad array of technological options that feasibly can be used in the major subsystems of a tactical training device. Of special interest is the identification of low-cost, commercially available, state-of-the-art microprocessor-based technology from which off-the-shelf components can be configured to support training of well-defined tactical leader skills. Given an identification of potential media/ device combinations and a thorough understanding of the tactical leader tasks, it may then be possible to configure lowcost, exportable training devices for the purpose of exposing greater numbers of platoon leaders to a variety of real-time threat situations in preparation for the complex problem-solving demands of the battlefield.

The project was conducted in two successive phases with the respective research activities governed by two objectives: (1) assess current and projected tactical training methodologies to identify deficiencies in the state-of-the-art, and (2) identify alternative media/device configurations with potential for supporting training on tactical leader tasks for combined arms units below battalion level. Research associated with the first objective has been completed and findings are presented in a separate report. The present report addresses the second objective; identification of media/device configurations.

Background

It is well known in the Army training community that a number of factors severely limit both the amount and quality of tactical training in field settings. Compressed training time, high ammunition and fuel costs, and restricted range space are the most frequently cited factors which hamper the conduct of full scale field exercises. Given these constraints, it is very likely that platoon leaders and company commanders receive insufficient practice in the effective execution of command, control and communication (C^3) procedures. If track commanders and their leaders are expected to respond to an adverse numerical threat in a coordinated and decisive fashion, it is essential that small unit leaders be provided with repeated opportunities to master the real-time paced skills required in a demanding battlefield environment. It is further realized that the introduction of highly mobile weapon systems and new doctrine in the near future -- focusing on the ability to out-maneuver and to react faster than the enemy -- underscores even more so the need to attain high levels of proficiency in applying tactical principles.

Although it might be reasonable to assume the existence of a variety of non-field training methods and devices which compensate for logistical obstacles associated with field exercises, such an assumption would be in error. Findings from the previous phase of this research could pinpoint

only piecemeal efforts taken thus far for addressing critical tactical aspects of the platoon leader's and company commander's job (Henriksen, Jones, Sergent & Rutherford, 1984). Simply stated, there is a scarcity of non-field tactical training devices which will give small unit leaders the necessary practice in assessing the threat situation, executing C^3 procedures, anticipating enemy reaction, engaging in rapid-pressure decision making, and insuring the optimal use of friendly assets. While battle simulations appropriate for company and platoon operations (e.g., Dunn-Kempf, BLOCKBUSTER) are not encumbered by large resource costs common to field exercises, the manual nature of these simulations prolong game time and seriously distort the real time perspective that combat leaders need to acquire for mastering information processing and decision making tasks. The use of more sophisticated, computer-driven battle simulations (e.g., CATTS, ARTBASS) alleviates the lengthy game mechanics associated with manual simulations; however, these simulations are directed at higher echelons of command.

The question arises as to the applicability of procedure trainers such as the Observed Fire Trainer (OFT), MK-60 Tank Gunnery Trainer, and Conduct of Fire Trainer (COFT). To be sure, these devices are useful in providing training on a given subset of tasks, especially those tasks where the platoon leader has to follow step-by-step procedures. For example, the platoon leader in his role as tank commander should find the COFT beneficial in improving his ability to acquire and shift targets. At the same time, the platoon leader must perform a myriad of other tasks above and beyond gunnery. Procedure-oriented trainers like the COFT, however, do not allow platoon leaders to gain proficiency on near simultaneous tasks such as maneuvering the platoon under direct and indirect fire, process information on battlefield cues, responding to and giving direction over company and platoon nets, compensating for execution failures, adapting to an NBC environment, anticipating the location of the opposing force, maintaining platoon integrity and so forth. These rapid-paced, time-sharing tasks which often exceed the information processing capacity of the overwhelmed platoon leader are not well represented in the current inventory of non-field training methods, including the gunnery devices.

Since the opportunity for tactical training in both field and non-field settings is constrained, it is even more important to ensure that the tasks selected for training are those that will influence the outcome of combat operations. During the past few years, the Army Research Institute has sponsored a programmatic effort to identify critical tactical leadership tasks performed by company commanders, platoon leaders, platoon sergeants and tank commanders. In a recent study, tasks performed during platoon operations by platoon leaders within each of four mission phases were evaluated in terms of criticality (Drucker, 1982). Those with the highest ratings were recommended for training. To facilitate further training program development of tactical leadership tasks, a new format for the preparation of training objectives has been devised; prototype training objectives for those platoon leader tasks with the highest criticality ratings have been prepared (O'Brien and Drucker, 1983).

Perhaps the most promising approach for dealing with the tactical training dilemma is the optimum utilization of advanced technology. The accelerated growth of state-of-the-art technological options -- 16 and 32 bit microcomputers, videodisc storage and retrieval, voice recognition and synthesis, high resolution graphics -- has perked the interest of those in the Army training community looking for fresh and innovative approaches. The concomitant trends of advanced technology towards lower costs and miniaturization promise to bring training devices that are readily available, exportable, and highly reliable. The potential of computer-based technology to support tactical training on those information processing and C^3 tasks not well covered by traditional training methodologies is especially noteworthy.

Brown (1983a) has cautioned that the increased combat effectiveness brought about by new technology will remain unrealized unless technology is used as well to provide training to fully exploit that potential. In a search for both short and long-term technological solutions to training, Brown advocates the judicious utilization of a variety of technological systems -- the Multiple Integrated Laser Engagement System (MILES), the Tank Weapon Gunnery Simulation System (TWGSS), more realistic targets through the use of visual modification kits (VISMOD) and robotic technology, simulators (Unit Conduct of Fire Trainer) and inexpensive microcomputer table top trainers. It is realized that these systems are not without their limitations and that a fully integrated and balanced approach to training is required. At a recent NATO commander's conference, Brown (1983b) stresses the need to do more with less resources and to master the basics by employing a "crawl, walk, run" approach to field exercises. Only after platoon leaders learn to crawl with map exercises, terrain walks and tactical exercises without troops, do they learn to walk with command post exercises and command field exercises. Only after these preceding stages are mastered, are officers allowed to expend the full resources associated with running full-up with combined arms units. There is a need to apply this same integrated building block approach to the use of training technology as well, especially if we expect small unit commanders to master the doctrinal changes that a technologically complex battlefield environment will demand.

The next section of the report describes a procedure for the identification of an array of technological options that may possibly be used in the major subsystems of tactical training devices. To guide the appropriate selection and subsequent utilization of this technology, the procedure evaluates the potential training device configurations against functional capability requirements derived from the critical tactical leadership tasks identified in the previously cited research.

METHOD

To accomplish the objectives associated with this phase of the project, research activities were conducted along two parallel tracks: (1) a scenario development track that led to the establishment of functional capability requirements, and (2) an identification of technological options track that led to the determination of compatible media/device configurations. These two tracks merged when the potential devices were evaluated with respect to the functional capability requirements derived from the scenarios. The potential devices were rank ordered with respect to functional capability requirements and other relevant evaluation criteria thus providing a decision aid for the selection of media/device configurations with the greatest promise for supporting training on the specified critical tasks. The potential devices also were classified according to projected development effort.

The steps in Figure 1 portray the sequence of research activities for this phase of the project.

Specify Critical Tasks

The present study utilized the findings of previous research sponsored by ARI for specifying critical tactical leadership tasks performed in combat by platoon leaders. Table 1 shows the critical platoon leader tasks organized by platoon operations that previous research recommended for training (Drucker, 1982). To show the relationship between these recommended tasks and the Division 86 Tank Platoon Mission Training Plan (TC 17-15-1), the column at the right gives the corresponding task number in the Mission Training Plan. Also shown in the table (in parentheses) are the mission phases and missions in which the platoon operation takes place. Those tasks marked by asterisks in Table 1 under the Initiate Direct Fires in Platoon Sector and Immediate Action platoon operations were selected for scenario development. Taken from both offensive and defensive perspectives, these tasks represent an integrated set of tasks of sufficient scope for the establishment of functional capability requirements.

It should be noted that Series J TO&E, implemented under Division 86 organization and introduced after the completion of Drucker's work, has converted a TOW section to a TOW platoon with its own command and control element under the control of the company commander. Consequently, the three tasks related to employment of the TOW section under the platoon operation Initiate Direct Fires in Platoon Sector have been changed for purposes of scenario development to reflect interaction with a TOW platoon leader.

Review Training Objectives and Source Documentation

Also part of ARI's programmatic research in the area of tactical training has been the establishment of training objectives for those critical tactical leadership tasks identified in Table 1. While fairly

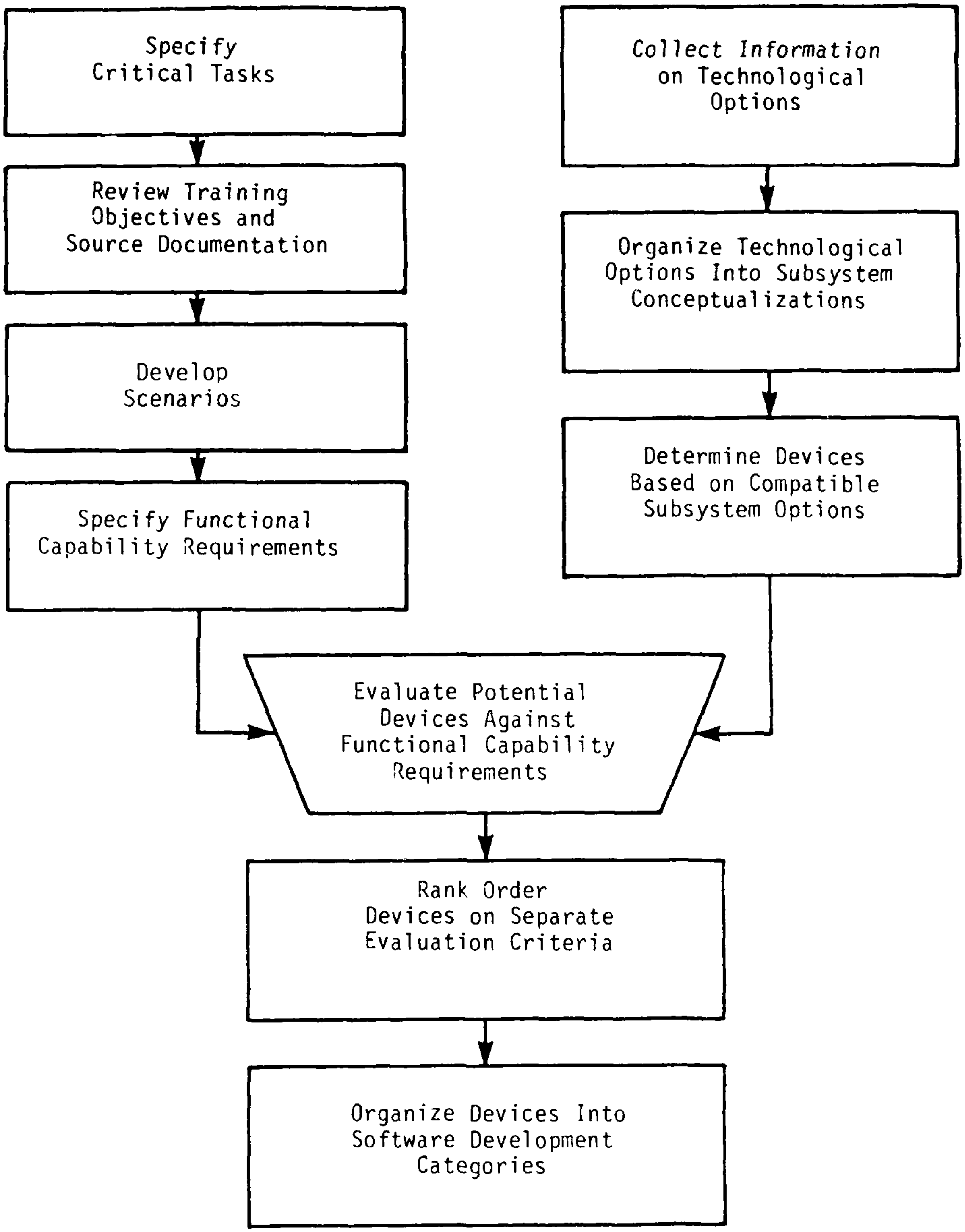

Figure 1. Sequence of Research Activities.

Table 1

Platoon Leader Tasks Recommended for Training
(Adopted from Drucker, 1982)

		MTP TC-17-15-1 Task No.
CONDUCT FIRE AND MANEUVER (Fire and Maneuver Phase, Hasty Attack Mission)		
	1. Issues FRAGO	037, 038
	2. Directs movement into attack position	076, 173
	3. Directs movement into attack formation	076, 173
	4. Directs movement out of attack position	076, 173
	5. Requests indirect fires	076, 173, 301
	6. Adjusts indirect fires	076, 173, 301
	7. Directs targets of opportunity be engaged	137
	8. Directs fire and maneuver be conducted	076, 173
IMMEDIATE ACTION (Action on Contact Phase, Movement to Contact Mission)		
*	1. Directs smoke be popped	301
*	2. Direct movement into defilade position	147
*	3. Submits SPOTREP	147
*	4. Directs enemy be engaged	147
*	5. Requests indirect fires	147
*	6. Requests indirect fires be shifted	147, 301
INITIATE DIRECT FIRES IN PLATOON SECTOR (Direct Fire Phase, Defend Battle Position Mission)		
*	1. Designates targets to TOW section	
*	2. Monitors TOWs	
*	3. Submits SPOTREP	147
*	4. Directs targets be engaged with TIS	137
*	5. Directs enemy be engaged	137
*	6. Requests indirect fires	301
*	7. Requests indirect fires be adjusted	301
*	8. Requests TOW section reinforce platoon fire	
*	9. Submits SITREP	
ORGANIZE PLATOON BATTLE POSITION (Occupy and Organize Battle Position Phase, Occupy Battle Position Mission)		
	1. Designates sectors of fire	137, 165
	2. Designates tank targets	137, 165
	3. Checks positions for suitability	165
	4. Directs tanks move to good fields of fire	165
	5. Assigns alternate positions	165
	6. Directs range cards be prepared	165
	7. Directs chemical alarms be emplaced	165
	8. Directs obstacles, mines, and flares be installed	145, 165
	9. Coordinates with FIST Leader	165
	10. Coordinates with TOW section leader	165
	11. Coordinates with adjacent platoon leaders	137
	12. Prepares a fire plan	137
	13. Reconnoiters assigned alternate position	165
	14. Selects and announces withdrawal routes	165
	15. Plans displacement	165
	16. Requests team fire plan	
	17. Requests wire communications be installed	165

successful standardized procedures exist for developing training objectives for equipment oriented, procedural tasks, a new format was needed to encompass the unique nature of tactical leadership tasks. Unlike procedural tasks, tactical leadership tasks involve a decision and command component. Furthermore, it is difficult to set tactical performance standards since the conditions under which the tasks are performed are situation dependent. Because of variable battlefield conditions, tasks performed in a highly fixated, stereotyped fashion regardless of the situation may have detrimental consequences. For these reasons, O'Brien and Drucker (1983) developed a new format along with prototype training objectives for tactical leadership tasks listed in Table 1. This document served as a valuable resource during scenario development and in specifying functional capability requirements. To insure technical accuracy and compatibility with new doctrine, other source documentation was used as well. Table 2 lists the source documentation used for scenario development.

Scenario Development

As indicated earlier, critical tasks were selected from both offensive and defensive platoon operations for scenario development. Scenarios were written for six offensive tasks for the platoon operation Immediate Action and for nine defensive tasks from the platoon operation Initiate Direct Fires in Platoon Sector. Altogether there are three defensive scenarios and one offensive scenario. For each set of tasks for which scenarios were developed, a situational outline and preliminary terrain sketch were first created. Factors of METT-T (Mission, Enemy Situation, Terrain, Troops Available-Time Available) served as a useful tool for consideration of essential battlefield conditions. Several iterations of the outline underwent development to insure a realistic and plausible flow of the scenario. A draft and draft final of the scenario were written in a format which specified prevailing conditions, visual/audio cues, a time line, student responses and background information. Particular attention was paid to insure that all actions of the platoon leader while performing the selected tasks were, indeed, included. Technical details (e.g., engagement ranges, effects of wind) also had to be accurate and realistic. The scenarios are presented in Appendix A.

Specify Functional Capability Requirements

In order to specify functional capabilities required of any tactical training medium, each scenario was examined for platoon leader actions and associated events (e.g., receiving a transmission, issuing an order, directing tanks in platoon). All platoon leader actions and associated events were listed. For each platoon leader action and associated event, the mechanics by which the platoon leader carried out the action were specified (e.g., using binoculars or tank commander's sight to acquire targets, reporting tactical events over radio to company commander, switching radio nets and directing platoon engagement). Functional capability categories were developed next which exhausted the range of

Table 2

Source Documentation for Scenario Development

Department of the Army. Mechanized infantry company TO & E (TOE 07-247J, Change 01). Washington, D.C.

Headquarters, Department of the Army. Tank company (M1) TO & E (TOE 17-237J, Change 03). Washington, D.C.

Headquarters, Department of the Army (1981, May). Tank gunnery (FM 17-12-1, Draft). Washington, D.C.

Headquarters, Department of the Army (1982, May). Tank gunnery (FM 17-12-2, Draft). Washington, D.C.

Map Deutschland 1:50,000; Ausgabe 3-DMG; Serie M745; L4924; Hunfeld.

O'Brien, R.E. & Drucker, E.H. (1983, January). Training objectives for tank platoon leaders covering tasks performed during four armor operations (Research product). Ft. Knox, KY: Human Resources Research Organization.

U.S. Army Armor School (1983, April). The division 86 tank platoon SOP. Ft. Knox, KY.

U.S. Army Armor School (1983, June). Division 86 tank platoon mission training plan (TC 17-15-1). Ft. Knox, KY.

U.S. Army Armor School (1983, September). Division 86 tank heavy company team mission training plan (TC 17-16-1). Ft. Knox, KY.

U.S. Army Intelligence and Threat Analysis Center (1978, August). Soviet army operations (IAG-13-U-78). Arlington, VA.

U.S. Training and Doctrine Command (1983, April). The tank and mechanized infantry company team (FM 71-1, Coordinating Draft). Ft. Eustis, VA.

U.S. Training and Doctrine Command (1983, April). The division 86 tank platoon (FM 17-15, (Test) Coordinating Draft). Ft. Eustis, VA.

U.S. Training and Doctrine Command (1982, August). Soviet army operations and tactics (FM 100-2-1). Ft. Eustis, VA.

mechanics necessary to exercise the identified tasks in the tactical scenario. A list of functional characteristics was generated for each functional category to serve as anchors along a behaviorally anchored rating scale. The rating scale, covering a range of functional characteristics from fully simulated representations to nominal representations can be found in Appendix B.

Collect Information On Technological Options

Simultaneous with the development of scenarios and functional capability requirements, research staff collected information on a wide range of technological options. The options ranged from relatively standard audio-visual equipment to state-of-the-art microprocessor technology. The following sources and techniques were used for gathering information on technological options.

- Letters of inquiry. Approximately three hundred letters of inquiry were sent to manufacturers of audio-visual, microprocessor, and peripheral equipment. Product literature was received from 80% of the inquiries.

- Review of popular computer magazines and newsweeklies. Various popular computer magazines and newsweeklies were examined on a periodic basis for the information they provide on new computer products.

- Vendor demonstrations. Vendor demonstrations at conferences and expositions provided an initial assessment of the capability of different computer products.

- Review of research literature. A review of published research product reports, survey of professional journals, proceedings from professional conferences, and evaluations of advanced training technology were conducted.

- Interviews with professional contacts. Interviews were conducted with agency representatives responsible for policy and development of tactical training programs. The purpose of the interviews was to obtain information on projected training devices not likely to be found in the current literature.

- Analysis of existing systems. To further establish a range of technological options, existing training devices were examined. Technological components making up the training devices were examined.

Organize Technological Options Into Subsystem Conceptualizations

Once the technological options were identified, they were organized into generic subsystem conceptualizations. The process of arriving at generic subsystem conceptualizations was iterative in nature. The clas-

sification scheme had to be of sufficient breadth to incorporate audio-visual, video, and microprocessor-based technologies yet not so broad as to lose its organizing function. The subsystem conceptualizations were based on an exhaustive set of categories under which all technological options could be subsumed. Terminology in current use in the professional vernacular was employed to enhance clarity and common understanding. The main subsystems included Input, Storage, Control, and Output. Output was further divided into Visual Display, Audio, and Hard-Copy subsystems. An overview of the subsystems arranged according to microprocessor, video, and audio-visual components appears as Table 5 in the Results section.

Determine Devices Based On Compatible Subsystem Options

Matrices were prepared showing all conceivable subsystem components in combination. All component options that could be conceived as technically compatible were identified and collectively served as a candidate pool from which a set of potential tactical training devices could be derived. Because of the vast number of possibilities that exist for deriving potential devices, selected criteria were employed for arriving at a representative range of potential devices. These criteria along with associated matrices are presented in the Results section.

Evaluate Potential Devices Against Functional Capability Requirements

As indicated earlier, a behaviorally anchored rating scale was developed for each functional capability category which was then used for evaluating each of the potential devices. Altogether there were twelve functional capability categories, the first eight of which dealt with requirements for exercising critical platoon leader tasks and the latter four of which dealt with desirable instructional features that a tactical training device should employ. A modified Delphi technique was used in evaluating the potential devices by means of functional capability rating scales. In brief, the Delphi technique is an iterative decision making process whereby analysts independently rate each item after studying it, present the rationale of their ratings, and then rerate the item. The intervening presentation of rationale between ratings allows divergent views to be aired, misconceptions to be corrected, and common criteria to be used as a basis for rating. The pure form of the Delphi technique insulates the raters from any form of face-to-face group interaction to avoid the bandwagon effect stemming from majority opinion or that of a persuasive individual. The present raters, however, felt that the benefits of face-to-face communication outweighed the potential disadvantages. Each device, therefore, was initially rated independently by four evaluators--two behavioral scientists, a computer specialist, and a military specialist. A discussion of the ratings then was held in a group setting followed by a second rating effort. With respect to the first eight functional capability categories, ratings were made for each task selected for scenario development across the potential devices. For the last four functional capability categories concerned with instructional features, ratings were made across devices without specifying individual

tasks. Each rater also was asked to estimate the percentage of tasks that the device could integrate or allow to be performed simultaneously.

Rank Order Devices On Separate Evaluation Criteria

To arrive at an overall rank order of the suitability of the potential devices for prototype development, the potential devices were rank ordered along the criteria listed below.

- Functional Capability. To what extent does the media/device combination satisfy the functional capability considerations across the selected tasks. The rank order for functional capability was based upon the overall mean ratings of the devices.

- Task Integration. To what extent does the media/ device combination integrate the various functional capabilities within a task as well as between tasks? The rank order for task integration was based upon the means of the task integration rating procedure.

- Instructional Features. To what extent will the media/device combination facilitate student performance and instructor administrative duties?

- Software Development Effort. To what extent will the media/device combination keep software development to a minimum?

- Development Tool Requirements. To what extent will the media/device combination minimize the need for off-the-shelf hardware and software systems tailored to creating applications software and hardware?

- Hardware Development. To what extent will the media/device combination keep hardware modifications and development of component interfaces at a minimum?

- Growth Potential. To what extent is the media/ device combination conducive to incremental enhancement of functional capability?

- Technical Feasibility. To what extent will the media/device combination minimize technical risk associated with producing instructional materials?

Once the media/device combinations were rank ordered on the separate criteria, their overall ranks were determined by taking the sum of the rankings on the separate criteria

Organize Devices Into Software Development Categories

Since all of the components of the various media/device combinations are commercially available as off the-shelf packages, hardware development was not considered as crucial a factor as originally anticipated.

More important and often unrecognized is the amount of software development that is required to bring a training device to fruition. For this reason, the media/device combinations, in a final analysis, were sorted into three software development categories. The software development categories were the number of professional staff months -- three to six months (moderate), seven to twelve months (substantial), and thirteen to eighteen months (extensive) -- that it would take to produce two hours of instructional material.

RESULTS

Several different sets of results will be reported in this section and its associated appendices. The first set is organized under the heading of Scenarios and Functional Capability Requirements. It is here that the functional capabilities required of any tactical training device are derived from the scenarios. The second set of results, Determination of Potential Devices, focuses on an array and description of technological options, their organization into subsystem conceptualizations, and their resultant configuration into potential tactical training devices. The third and final set of results, Evaluation of Potential Devices, first summarizes the matching of potential devices against the functional capability requirements and arrives at a rank ordering of devices on the basis of their fulfillment of functional requirements and other relevant criteria.

Scenarios and Functional Capability Requirements

Before scenarios were written, critical tactical leadership tasks performed by platoon leaders were identified. Research staff selected six offensive tasks from the platoon operation, Immediate Action (from a Movement To Contact Mission) and nine defensive tasks from the platoon operation Initiate Direct Fires in Platoon Sector (from a Defend Battle Position Mission). These tasks, selected for scenario development, were reported in Table 1, Method section.

An overview of the scenarios which appear in Appendix A is provided in Table 3. The table shows the number of times a task is exercised within a given scenario for each platoon operation. Scenarios were written for both offensive (Immediate Action) and defensive (Initiate Direct Fires in Platoon Section) platoon operations to exhaust the functional possibilities that are inherent in each type of operation.

Each scenario was examined for platoon leader actions and associated events in order to establish functional capability requirements. Once all platoon leader actions, associated events as well as the mechanics by which the platoon leader carried out the action were specified, functional capability categories were developed. The functional capability categories, in turn, led to the development of functional characteristics or requirements which served as anchors along a behaviorally anchored rating

Table 3

Tasks and Task Repetitions by Scenario

Tasks	Platoon Operations: Initiate Direct Fires in Platoon Sector			Platoon Operations: Immediate Action
	Scenario One	Scenario Two	Scenario Three	Scenario Four
*Direct enemy be engaged	3	4	3	1
Direct targets be engaged with TIS			2	
*Requests indirect fires	1	1	2	1
*Request indirect fires be adjusted		1		1
Designates targets to TOW platoon		1		
Request TOW platoon re-inforce platoon fire		1		
Monitors TOWs		2	3	
*Submits SPOTREP	4	3		1
Submits STAREP (SITREP)		4	1	
Directs smoke be popped				1
Directs movement into defilade position				1

NOTE: Scenarios were developed for nine tasks under Initiate Direct Fires in Platoon Sector and six tasks under Immediate Action. An asterisk (*) indicates tasks common to both platoon operations.

scale. The rating scales, used for assessing the extent to which the potential devices satisfied the functional requirements, are reported in Appendix B. Table 4 below summarizes the twelve functional capability categories and requirements. The first eight categories address requirements for exercising critical platoon leader tasks; the latter four address desirable instructional features.

Table 4

Functional Capability Categories and Requirements

Smoke Screen Representation	The device should simulate all smoke producing systems with respect to smoke generation capability, real-time coverage (initial generation and sustainment), dissipation (wind speed and direction) and degradation of hit probability.
US and OPFOR Vehicle Representation	The device should provide for realistic visual simulation of actual vehicles, vehicle movement, and movement rates as would be observed from the vantage point of the platoon leader.
US and OPFOR Weapons Representation	The device should fully simulate all visual and auditory aspects of weapon firings including weapon signatures and projectile impact, projectile flight time, hit probability, and reactions to return fire.
Directing Control of Engagement	The device should allow the platoon leader to issue initial engagement commands, make corrections, issue subsequent commands in real-time to platoon tanks, his own tank, supporting weapon systems, and provide for a real-time response.
Platoon Leader Outputs	The device should simulate real-time transmission of all tactical voice communication and visual communication signals.
Inputs to the Platoon Leader	The device should simulate the real-time receipt of all tactical voice communication, audio and visual battlefield cues, and visual communication signals.

Table 4 (Continued)

Functional Capability Categories and Requirements

Visual Observation Technique and Visual Representation	The device should fully simulate all available visual observation techniques (e.g., binoculars, tank commander's sight, thermal imagery sight) and all changes in the visual environment brought about by changes in tank position.
Terrain Representation	The terrain represented by the device should allow the platoon leader to have the same visual access of the battlefield as under combat conditions.
Familiarization and Initialization	The device and associated software should provide completely transparent functions for device mastering (e.g., cues, prompts, help key, human factored layout and labeling), ease of student response and data entry methods (e.g., touch pad), rapid log-on and log-off procedures, quickly accessed displays, and self-teaching modes for student and instructor.
Instructional Presentation	The device should fully support instructional presentation methods that challenge the student (e.g., variable difficulty levels, variable pacing for information processing tasks, uncertain outcomes, random access of material, hidden information, progressively increasing performance standards), allow exercise parameters and conditions to be reset for creation of new exercises, and allows for the creative use of mixed media.
Receipt of Feedback	The device and associated software should fully incorporate the receipt of response-contingent feedback during exercises, free-play interaction in

Table 4 (Continued)

Functional Capability Categories and Requirements

	real-time, instructor monitoring capability, error control, and instructor interdiction options, time-tagged performance record, situation playback, summative analysis of performance, and diagnostic feedback on specific tactical deficiencies.
Administrative/ Management Duties	The device should allow for complete administrative and management functions -- instructor access to platoon roster, student files, exercise control, recordkeeping and updating of new information -- thereby minimizing preparation and administrative time.

Determination of Potential Devices

An overview of audio-visual, video, and microprocessor-based technological components, organized by generic subsystems, is presented in Table 5. The generic subsystems include input, storage, control, and output (visual display, audio, and hard-copy) categories. Functional descriptions along with representative vendors of the components listed in Table 5 appear in Appendix C.

As a working definition, research staff defined a device as consisting of components from the input, control, storage, and output subsystems. Because of the vast number of possibilities that exist for configuring components from these basic four subsystems, the following procedure was employed for arriving at a representative set of low-cost devices. For the microprocessor-based technology, a matrix was prepared displaying all conceivable combinations of input, storage, and output components for each of five microprocessor (control) levels.

The first microprocessor level in Table 6 is the hand-held computer (dedicated bus). Hand-held computers are typically built around a 6502 microprocessor chip and have limited memory and information handling capability. Many hand-held computers are referred to as dedicated bus machines because of the inability of a non-standard bus to interface with peripherals from other vendors. As a result of their small size, portability is their most distinguishing feature.

Table 5

Overview of Microcomputer, Video, and Traditional Audio-Visual Subsystem Components

	INPUT	STORAGE	CONTROL	OUTPUT: VISUAL DISPLAY	OUTPUT: AUDIO	OUTPUT: HARD-COPY
Microcomputer-Based	Qwerty-Type Keyboard Specialized Capacitive Keypad Light Pen Touch-Sensitive Digitizer Electromagnetic Digitizer Sonic Digitizer Light Detector Digitizer Joystick Displacement Joystick Force-Operated Joystick Switch-Activated Joystick Trackball Dial Thumb Wheels Mechanical Mouse Optical Mouse The Depraz Mouse Voice Entry Unit	Cassette Tape 1/4" Data Cartridge Floppy Disk Winchester Hard Disk Bubble Memory	Hand-Held Computer (Dedicated Bus) Desktop Microcomputer (Dedicated Bus) 8-bit Microcomputer 16-bit Microcomputer Multiple Microprocessors	Vector Graphics Monitor Raster Scan Display Intelligent Color Raster Scan Display Flat-Panel Plasma Display Liquid Crystal Display	Voice Synthesizer Module Voice Store and Forward Module (could also be placed under storage)	Dot Matrix Impact Printer Multi-Mode Dot Matrix Printer Daisy-Wheel Impact Printer Ink-Jet Printer Thermal Printer Flatbed Plotter Drum Plotter Electrostatic Plotter Graphic Film Recorder Hard Copy Unit
Video-Based	Video Free-Hand Writer	Capacitance Videodisc Optical Videodisc Video Tape	Video Interface	Video Monitors and Receivers Large Screen	Interactive Video Player Video Tape Player Videodisc Player Video Projector	
Traditional Audio-Visual	Workbook Manual Controls Audio Tape Recorder Programmed Instruction Equipment	Motion Picture or Still Picture Film 35mm Slide Filmstrip Continuous Loop Viewgraphs Microfilm/ Microfiche Audio Tape Photograph Print Graphics	Programmer Encoder Synchronizer Dissolve Controls Remote Control Random Access Multiplexer	Motion Picture Projector Filmstrip Projector Slide Projector Programmed Instruction Equipment Overhead Projector Opaque Projector Tachistoscope Front and Rear Projection Screens Microform Reader Print Graphics	Record Player Audio Tape Player Headset Headphone	Print Graphics Photograph Microform Reader Printer

The desktop microcomputer (dedicated bus) is shown as the second level in Table 6. These machines also utilize an 8-bit chip but their non-standard bus severely limits growth potential and ties the user to a particular manufacturer. An advantage of a desk top microcomputer is the larger visual display allowing for low resolution alphanumeric and sub-cell graphics.

The next level is an 8-bit computer with a standard bus (e.g., the S-100 bus) which is considerably more robust than a computer with a dedicated bus. Table 6 shows that the current crop of 8-bit computers are capable of interfacing with a wide assortment of input, storage and output devices. These computers have the largest established software base as a result of their initial acceptance and low cost. With 64K bytes of random access memory (RAM) typically available to the user, these machines are capable of running programs and performing information handling chores for applications which do not become overly ambitious. Clock speed (expressed in mega-Hertz) at which the chip is driven and word size (bits directly addressed and processed by the chip) are two factors accounting for slower operation of these machines when compared to the next level, their 16-bit successors.

The wider word width of the 16-bit microprocessors provides for greater processing power with improved instruction execution times. The major advantage, however, is the ability of the 16-bit machines to directly access large amounts of RAM with their extended address busses. With a megabyte or more of memory address space, intricate programs and high resolution graphics are possible. Furthermore, the extra memory allows programmers to write in languages other than the tedious assembly language. With abundant memory, programmers can write easily in higher level languages thus assuring a growing supply of transportable software.

The fifth level in Table 6 indicates that some computers are configured with more than one microprocessor. Multiple microprocessors permit simultaneous processing by two or more processing units that share a common memory and peripheral devices. For a particular application, one microprocessor might be responsible for graphics tasks while the other microprocessor is simultaneously performing numerical computations. Computers with multiple microprocessors are well suited to sophisticated, high resolution graphics with near real-time requirements. Table 6 shows that with increases in processing level from dedicated bus microprocessors to multiple processors, the number of conceivable components that can be combined to configure devices expands considerably.

To eliminate duplication of functionality and to arrive at a more manageable number of potential devices, criteria were devised for arriving at a smaller pool of candidate components from which devices could be configured. These criteria and the resulting candidate components within each subsystem are shown in Appendix D. Selected candidate components from the input, storage, and output subsystems were combined with the five microprocessor levels to derive a range of potential

Table 6

Conceivable Components for Potential Device Configurations

	Subsystem Components	Hand-Held Computer (Dedicated Bus)	Desktop Microcomputer (Dedicated Bus)	8-bit Microcomputer	16-bit Microcomputer	Multiple Microprocessors
INPUT	Keyboard	●	●	●	●	●
	Keypad			●	●	●
	Light Pen			●	●	●
	Digitizer			●	●	●
	Joystick		●	●	●	●
	Trackball			●	●	●
	Dial			●	●	●
	Thumb Wheels			●	●	●
	Mouse			●	●	●
	Voice Entry			●	●	●
STORAGE	Cassette Tape	●	●	●		
	Cartridge Tape			●	●	●
	Floppy Disk		●	●	●	●
	Hard Disk			●	●	●
	Bubble Memory			●	●	●
OUTPUT (VISUAL DISPLAY)	Vector Graphics				●	●
	Raster-Scan Display					
	(Alphanumeric)		●	●		
	(Subcell)		●	●		
	(Low Resolution)		●	●		
	(Medium Resolution)				●	●
	(High Resolution)				●	●
	Intelligent Raster-Scan				●	●
	Plasma Display				●	●
	Liquid Crystal Display	●				
OUTPUT (AUDIO)	Voice Synthesizer			●	●	●
	Reconstructed Voice			●	●	●
OUTPUT (HARD-COPY)	Dot-Matrix Printer		●	●	●	●
	Multi-Mode Printer			●	●	●
	Daisy-Wheel Printer			●	●	●
	Ink-Jet Printer			●	●	●
	Thermal Printer	●	●	●	●	●
	Plotter				●	●
	Graphic Film Recorder				●	●
	Hard Copy unit				●	●

devices. This range of potential device configurations is shown in Table 7. Device configurations one through fifteen in the table are built upon the five microprocessor levels which increase with respect to processing power and speed as well as qualitatively different components from the other three subsystems. Devices sixteen through twenty in Table 7 are based upon conventional audio-visual technology. An overview of audio-visual components arranged according to subsystems can also be found in Table 5. Functional descriptions of these components are presented in Appendix C as well. Audio-visual components derived from input, storage, control and output subsystems, taken together, serve to define a given audio-visual device. The five audio-visual devices vary with respect to motion vs. still visuals, degree of programmability, and ease of instructional presentation.

Evaluation of Potential Devices.

Each potential device was evaluated by means of the functional capability rating scales reported in Appendix B. The first set of ratings focused on the extent to which the potential device matched functional capability characteristics drawn from the eight functional capability categories. Ratings were made by four members of the research staff for each functional capability category on each of the critical tasks. Table 8 shows the means and standard deviations (calculated across raters and functional capability categories) as a function of the critical tasks and potential devices. Only the second set of ratings stemming from the Delphi technique were used for data reduction purposes. The bottom two rows of Table 8 show the functional capability grand means (calculated across tasks) for each device and the respective rankings based on these means. In general, the multiple processor devices held the top ranks, followed in descending order by two of the audio-visual devices that had visual motion capability, the 16-bit devices, the audio-visual still frame devices, the 8-bit devices, and finally, the dedicated bus devices. Other noteworthy characteristics of the data include relatively low functional capability means across the devices, especially for the 8-bit devices and those with limited memory capability. The relatively high rankings for audio-visual devices with visual motion capability and devices incorporating a videodisc seems to underscore the importance of visual systems with good fidelity for tactical training. With respect to differences in variability of ratings among the devices, notable standard deviation trends were not discerned with the exception of very small standard deviations for the low-end devices (especially devices one through four). All four raters were in close agreement across the functional capability categories that these devices were quite limited.

In addition to evaluating the potential devices on how well they satisfy each separate functional capability required by the tasks, it is also necessary to assess how well the devices are able to integrate the various functions within a task as well as the extent to which separate tasks can be integrated or performed simultaneously. This is an essential consideration given the time-sharing and multitasking nature of the platoon leader's job. Each rater, therefore, estimated the percentage

Table 7

Potential Devices Organized by Subsystems

	INPUT	STORAGE	CONTROL	OUTPUT		
				VISUAL DISPLAY	AUDIO	HARD-COPY
Device 1	Keyboard	Built-in	6502 chip 8K RAM Hand-held size dedicated bus computer	40 character Liquid Crystal Display		Thermal Printer
Device 2	Keyboard with Numeric Keypad	Cassette Tape	8-bit Z80A chip Dedicated bus microcomputer 16K RAM	12 inch subcell graphics monitor		Dot-Matrix Printer
Device 3	Keyboard with Numeric Keypad	5¼ inch Floppy Disk	8-bit 6502A chip 64K RAM Some expansion	12 inch, low resolution pixel graphics monitor		Dot-Matrix Printer
Device 4	Intercept-Beam or Touch-Sensitive Screen or Light Pen	5¼ inch Floppy DIsk	8-bit 6502A chip 64K RAM expandable	12 inch, low resolution pixel graphics monitor plus Instructor's monitor	Voice Synthesizer	Dot-Matrix Printer
Device 5	Keyboard and Mouse	Dual 5¼ inch Floppy Disks and Optical Videodisc	8-bit 6502A chip 64K RAM expandable Videodisc Player	Video monitor	Audio channel available from videodisc	
Device 6	Specialized Capacitance Keypad, Graphics Digitizer, Touch-Sensitive Screen and Joystick	Winchester Hard Disk and 5¼ inch Floppy Disk	8-bit Z80A chip 64K RAM expandable	13 inch, medium resolution pixel graphics monitor plus Instructor's monitor	Voice Synthesizer	Flat Bed Plotter and Ink Jet Printer

Table 7 (Continued)

	INPUT	STORAGE	CONTROL	OUTPUT: VISUAL DISPLAY	OUTPUT: AUDIO	OUTPUT: HARD-COPY
Device 7	Keyboard	Dual 5¼ inch Floppy Disks and Audio Tape	8/16-bit 8088 chip 64K RAM expandable to 512K RAM Audio Tape Player	13 inch, medium resolution pixel graphics monitor	Recorded Voice	Dot-Matrix Printer
Device 8	Keyboard and Touch Screen or Light Pen	10M Byte Winchester Hard Disk and 5¼ inch Floppy Disk	16-bit 68000 chip 128K RAM	15 inch, medium resolution pixel graphics display		Multi-Mode Printer
Device 9	Keyboard and Mouse	Dual 5¼ inch Floppy Disks and Optical Videodisc	16-bit 68000 chip 128K RAM expandable Videodisc Player	Video Monitor	Audio channel available from videodisc	
Device 10	Keyboard, Graphics Digitizer, Mouse, Intercept-Beam Screen and Voice Entry Unit	10M Byte Winchester Hard Disk and 5¼ Floppy Disk	16-bit 68000 chip 128K RAM expandable	19 inch, pixel graphics monitor plus Instructor's terminal with keyboard	Voice Synthesizer	Dot-Matrix Printer and Electrostatic Plotter
Device 11	Keyboard with Specialized Keypad	10M Byte Winchester Hard Disk	16-bit 68000 chip 128K RAM expandable	12 inch Plasma Display		Flat Bed Plotter
Device 12	Specialized Capacitance Keypad, Touch-Sensitive Screen Graphics Digitizer, Joystick and Voice Entry Unit	10M Byte Winchester Hard Disk and Dual 5¼ inch Floppy Disks	16-bit Dual MC68000 microprocessors 128K RAM Stand-alone or used in conjunction with host computer	19 inch, high resolution pixel graphics monitor, plus 19 inch intelligent raster-scan display for Instructor	Voice Synthesizer	Multi-Mode Printer and Electrostatic Plotter
Device 13	Keyboard	10M Byte Winchester Hard Disk and 5¼ inch Floppy Disk	Multiple Microprocessors (two MC68000 chips) 128K RAM system processor 16K EPROM graphics processor	Intelligent high resolution raster-scan display	Voice Synthesizer	Flat Bed Plotter and Ink Jet Printer

Table 7 (Continued)

	INPUT	STORAGE	CONTROL	OUTPUT		
				VISUAL DISPLAY	AUDIO	HARD-COPY
Device 14	Keyboard with Keypad, Inter-cept-Beam Screen, Graphics Digitizer, Mouse and Voice Entry Unit	10M Byte Winchester Hard Disk and Data Cartridge Tape	Multiple Micro-processors (two MC68000 chips) 128K RAM system processor, 16K EPROM graphics processor	High resolution pixel graphics display and high resolution intelligent raster-scan terminal for Instructor	Voice Synthesizer	Multi-Mode Printer and Electrostatic Plotter
Device 15	Keyboard with Keypad, Inter-cept-Beam Screen and Force-Operated Joystick	10M Byte Winchester Hard Disk and Dual 5¼ Floppy Disks	Multiple Microprocessors (dual 68000) and host computer	19 inch high resolution color graphics monitor plus intelligent raster-scan terminal for Instructor		Hard Copy Unit and Multi-Mode Printer
Device 16	Workbook (can be con-sidered output as well)	35mm Slides and Audio Cassette Tape	Manual Controls	Front Projection Screen and Slide Projector	Audio Cassette Tape Player	
Device 17	Audio Tape Recorder	16mm Motion Picture Film with audio track	Remote Controls	Front Projection Screen and Motion Picture Projector (Analysis Type)	Sound capability with motion picture projector	
Device 18	Manual Controls	16mm Filmstrip and Audio Cassette Tape	Programmer, Synchronizer, and Random Access Controls	Rear Projection Screen and Filmstrip Projector	Audio Cassette Tape Player	
Device 19	Workbook, Audio Tape Recorder and Manual Controls	Video Cassette Tape with audio track	Programmer, Synchronizer, Remote Control and Random Access Controls	Video Monitor and Video Cassette Tape Player	Headset and sound capability with video tape player	
Device 20	Keyboard	35mm Slides, Audio Cassette Tape and Floppy Disk	Z80A Microprocessor 64K RAM Floppy Disk Drive	Rear Projection Screen, Multiple Slide Projectors and Tachistoscope	Audio Cassette Tape Player	Dot-Matrix Printer

Table 8
Rater Means, Standard Deviations and Rank Order of Potential Devices
With Respect to Functional Capability Ratings Within Tasks

Tasks Across Functional Capabilities	Media/Device Combinations									
	1	2	3	4	5	6	7	8	9	10
1. Directs Smoke be Popped	$\bar{X}$=.007 SD=.019	.043 .073	.178 .049	.214 .069	.436 .191	.357 .120	.250 .041	.378 .086	.464 .128	.478 .138
2. Directs Movement into Defilade Position	.008 .020	.050 .077	.192 .038	.225 .069	.475 .175	.383 .108	.258 .038	.408 .038	.492 .116	.528 .129
3. Submit SPOTREP	.007 .019	.043 .073	.178 .049	.214 .069	.436 .191	.357 .120	.250 .041	.378 .086	.464 .128	.478 .138
4. Directs Enemy be Engaged	.007 .019	.050 .071	.178 .049	.214 .069	.414 .227	.364 .111	.257 .034	.407 .034	.443 .167	.500 .104
5. Request Indirect Fires	.006 .018	.044 .068	.169 .053	.206 .068	.388 .223	.344 .118	.250 .037	.381 .080	.425 .162	.469 .131
6. Request Indirect Fires be Shifted	.006 .018	.044 .068	.169 .053	.206 .068	.388 .223	.344 .118	.250 .037	.381 .080	.425 .162	.469 .131
7. Designates Targets to TOW Section	.007 .019	.050 .071	.178 .049	.214 .069	.414 .227	.364 .111	.257 .034	.407 .034	.443 .167	.500 .104
8. Monitors TOWS	.007 .019	.050 .071	.178 .049	.214 .069	.414 .227	.364 .111	.257 .034	.407 .034	.443 .167	.500 .104
9. Directs Targets be Engaged With TIS	.006 .018	.044 .068	.169 .053	.206 .068	.388 .223	.344 .118	.250 .037	.381 .080	.425 .162	.469 .131
10. Request TOW Section Reinforce Platoon Fire	.007 .019	.050 .071	.178 .049	.214 .069	.414 .227	.364 .111	.257 .034	.407 .034	.443 .167	.500 .104
11. Submit SITREP	.006 .018	.044 .068	.169 .053	.206 .068	.388 .223	.344 .118	.250 .037	.381 .080	.425 .162	.469 .131
Grand Mean Across Tasks	.007 .000	.046 .003	.175 .007	.212 .006	.414 .027	.357 .012	.253 .004	.395 .014	.445 .021	.487 .019
Rank Order	20	19	18	17	9	12	16	10	8	7

Table 8 (Continued)

Tasks Across Functional Capabilities	Media/Device Combinations									
	11	12	13	14	15	16	17	18	19	20
1. Directs Smoke be Popped	$\bar{X}$ = .378 SD=.095	.543 .089	.636 .075	.678 .039	.681 .068	.285 .271	.618 .167	.295 .285	.533 .288	.343 .294
2. Directs Movement into Defilade Position	.400 .084	.570 .110	.642 .080	.683 .041	.675 .061	.299 .294	.653 .159	.311 .309	.556 .309	.367 .315
3. Submit SPOTREP	.378 .095	.543 .089	.636 .075	.678 .039	.681 .068	.285 .271	.618 .167	.295 .285	.533 .288	.343 .294
4. Directs Enemy be Engaged	.400 .076	.550 .082	.618 .109	.638 .090	.664 .063	.257 .291	.544 .302	.267 .305	.556 .309	.324 .309
5. Request Indirect Fires	.381 .088	.537 .083	.612 .095	.674 .073	.575 .239	.250 .271	.524 .281	.258 .284	.539 .285	.308 .289
6. Request Indirect Fires be Shifted	.381 .088	.537 .083	.612 .095	.674 .073	.575 .239	.250 .271	.524 .281	.258 .284	.539 .285	.309 .289
7. Designates Targets to TOW Section	.400 .076	.550 .082	.618 .109	.638 .090	.664 .063	.257 .291	.544 .302	.267 .305	.556 .309	.324 .309
8. Monitors TOWS	.400 076	.550 .082	.618 .109	.638 .090	.664 .063	.257 .291	.544 .302	.267 .305	.556 .309	.324 .309
9. Directs Targets be Engaged with TIS	.381 .088	.537 .083	.612 .095	.674 .073	.575 .239	.250 .271	.524 .281	.258 .284	.539 .285	.308 .289
10. Request TOW Section Reinforce Platoon Fire	.400 .076	.550 .082	.618 .109	.638 .090	.664 .063	.257 .291	.544 .302	.267 .305	.556 .309	.324 .309
11. Submit SITREP	.381 .088	.537 .083	.612 .095	.674 .073	.575 .239	.250 .271	.524 .281	.258 .284	.539 .285	.308 .289
Grand Mean Across Tasks	.389 .010	.546 .010	.621 .011	.662 .019	.636 .048	.263 .017	.560 .046	.273 .018	.546 .010	.325 .019
Rank Order	11	5.5	3	1	2	15	4	14	5.5	13

of tasks or task elements that the potential devices could conceivably integrate. Table 9 reports the estimated mean percentage of tasks and task elements (for the offensive and defensive tasks) that the potential devices could integrate. Grand means along with the resulting rank order are shown in the bottom row. The mean percentage range is considerable, extending from zero for Device 1 to seventy-nine percent for Device 15. Those devices with multiple processors (Devices 12, 13, 14 and 15), hard disk storage units, and which are conducive to multitasking, received the highest estimated mean percentages. Altogether, fifteen of twenty devices received estimated mean percentages of less than thirty, which reflects poor rater confidence in these devices to be used for multi-tasking purposes.

The devices were evaluated also in terms of instructional features that would facilitate students' performance and the instructor's administrative/management responsibilities. Research staff evaluated each device on the extent to which it would be conducive to efficient and easy to master familiarization and initialization procedures, challenging instructional presentation methods, receipt of feedback to student and instructor, and efficient administrative and management functions. Functional capability rating forms used for the evaluation of these instructional features appear in Appendix B.

With respect to these instructional features, Table 10 reports the means across raters for each device and the resulting rank order. Once again, the multiple processor devices held the highest ranks, most likely as a result of their greater versatility. These devices were followed in descending order by the 16-bit devices, the 8-bit devices, the audio-visual devices, and finally, the dedicated bus devices.

Table 11 lists the ranks across devices for the three functional capability categories discussed above along with the ranks for five additional evaluation criteria that need to be considered when assessing the suitability of potential devices for prototype development. These additional criteria have been described in the Method section and include software development effort, development tool requirements, hardware development, growth potential, and technical feasibility. The rank orders for these five criteria were based on the Delphi technique of assigning an initial set of ranks, discussing the rank orderings, and then assigning a final set of ranks. The rankings in the table are based on the overall rank of the individual ranks assigned by the research staff.

Inspection of the table shows, for the most part, that the rank ordering of the devices on these criteria follows a course similar to that of the other categories. The noteworthy exception occurs for the software development effort and the development tool categories. Here the devices receiving the top ranks for minimal software development effort and minimal development tool requirements were the audio-visual devices, followed in declining order by the multiple processors, the 16-bit devices, the 8-bit devices, and the dedicated bus devices. Since

Table 9

Estimated Mean Percentage of Tasks/Task Elements Media/Device Combinations Can Integrate With Resultant Rank Order for Devices

Tasks	Media/Device Combinations									
	1	2	3	4	5	6	7	8	9	10
Immediate Action (Offensive Tasks)	$\bar{X}$=.00	.75	2.50	4.25	4.75	7.50	7.00	14.25	11.75	23.25
Initiate Direct Fires in Platoon Sector (Defensive Tasks)	$\bar{X}$=.00	.75	2.50	4.25	5.50	7.50	7.00	24.25	11.75	33.50
Grand Mean	.00	.75	2.50	4.25	5.13	7.50	7.00	19.25	11.75	28.37
Rank Order	20	13	16	13	12	10	11	7	8	5

	11	12	13	14	15	16	17	18	19	20
Immediate Action (Offensive Tasks)	19.75	43.75	53.75	66.25	79.25	.67	2.00	3.00	3.33	7.67
Initiate Direct Fires in Platoon Sector (Defensive Tasks)	22.25	46.25	56.25	70.00	79.25	.67	2.00	3.00	3.33	7.67
Grand Mean	21.00	45.00	55.00	68.12	79.25	.67	2.00	3.00	3.33	7.67
Rank Order	6	4	3	2	1	19	17	15	14	9

Table 10

Rater Means for Instructional Feature Considerations
With Resultant Rank Order for Devices

Functional Considerations Across Tasks	Media/Device Combinations									
	1	2	3	4	5	6	7	8	9	10
Familiarization and Initialization	.06	.06	.40	.40	.40	.46	.40	.60	.46	.60
Instructional Presentation	.00	.00	.26	.26	.46	.40	.33	.46	.53	.60
Receipt of Feedback	.00	.00	.20	.20	.20	.20	.20	.40	.20	.40
Administrative/ Management Duties	.00	.00	.33	.33	.33	.46	.46	.46	.40	.66
Grand Mean	.02	.02	.30	.30	.35	.39	.38	.48	.40	.57
Rank Order	19.5	19.5	12.5	12.5	11	9	10	7	8	5

	11	12	13	14	15	16	17	18	19	20
Familiarization and Initialization	.60	.66	.66	.73	.73	NA	NA	NA	NA	.20
Instructional Presentation	.60	.66	.73	.73	.73	.13	.13	.13	.26	.33
Receipt of Feedback	.40	.60	.80	.80	.80	.00	.00	.40	.40	.46
Administrative/ Management Duties	.46	.66	.80	.80	.80	.00	.00	.00	.00	.20
Grand Mean	.52	.65	.75	.77	.77	.04	.04	.18	.22	.29
Rank Order	6	4	3	1.5	1.5	17.5	17.5	16	15	14

Table 11
Rank Order of Media/Device Combinations
On Evaluation Criteria

Media/Device Combinations	Evaluation Criteria: Functional Capability	Task Integration	Instructional Features	Software Development Effort	Development Tool Requirements	Hardware Development	Growth Potential	Technical Feasibility	Sum of Ranks	Overall Rank
M/DC 1	20	20	19.5	19	20	20	20	20	158.5	20
M/DC 2	19	18	19.5	18	19	19	19	19	150.5	19
M/DC 3	18	16	12.5	15	16	10.5	15	18	121	18
M/DC 4	17	13	12.5	16	17	12	12	16.5	116	17
M/DC 5	9	12	11	17	18	13	13	16.5	109.5	16
M/DC 6	12	10	9	13.5	14	9	8	9	84.5	9
M/DC 7	16	11	10	12	13	8	10	8	88	11
M/DC 8	10	7	7	10.5	12	7	7	7	67.5	7
M/DC 9	8	8	8	20	15	10.5	9	12.5	91	12.5
M/DC 10	7	5	5	13.5	11	6	6	5.5	59	5.5
M/DC 11	11	6	6	10.5	10	5	5	5.5	59	5.5
M/DC 12	5.5	4	4	9	9	4	4	4	43.5	4
M/DC 13	3	3	3	7	5	3	3	3	30	3
M/DC 14	1	2	1.5	8	6.5	2	2	2	25	2
M/DC 15	2	1	1.5	6	1	1	1	1	14.5	1
M/DC 16	15	19	17.5	1	2	18	18	15	105.5	15
M/DC 17	4	17	17.5	2	3	17	16.5	14	91	12.5
M/DC 18	14	15	16	3	4	16	16.5	12.5	97	14
M/DC 19	5.5	14	15	4	6.5	15	14	10.5	84.5	9
M/DC 20	13	9	14	5	8	14	11	10.5	84.5	9

all of the devices were comprised of off-the-shelf components, assigning ranks to the hardware development criterion was a relatively difficult task. Be that as it may, the low-end dedicated bus devices and the audio-visual devices were considered to be most in need of hardware modification and development; whereas, the more robust multiple processors were considered the least likely to require modification. The top rankings for growth potential and technical feasibility, once again, went to the multiple processor and 16-bit devices, followed by the 8-bit, audio-visual, and dedicated bus devices.

When all the ranks were summed across the evaluation criteria for each device to arrive at an overall rank, it was not surprising, given the above trends, to find the multiple processor devices occupying the top ranks followed by the 16-bit devices with the 8-bit and dedicated bus devices holding the bottom ranks.

The point was made earlier that software development rather than hardware development is a crucial factor often overlooked during considerations of training device development. Table 12 shows the devices categorized according to the estimated number of professional staff months required to produce two hours of instructional material. Of particular note is the greater amount of staff time required to produce instructional material on the less capable microprocessor-based devices.

Table 12

Devices Categorized According To
Number of Professional Staff Months
To Produce Two Hours Of Instruction

Moderate (6 months or less)	Substantial (7 months to 12 months)	Extensive (13 months to 18 months)
16, 18	13, 14, 15, 17, 19, 20	3, 4, 5, 6, 7, 8, 9, 10, 11, 12

NOTE: Due to the limited capabilities of Devices 1 and 2, developmental efforts to produce two hours of instruction exceeds reasonable projections.

DISCUSSION

The information processing and decision making demands confronting the small unit leader on the modern battlefield are becoming better understood. The armor platoon leader not only has to interact efficiently with his own crew to optimize his own tank's performance, but as a small unit leader, he simultaneously must anticipate enemy deployment, provide direction to his tank commanders, employ weapon systems where they will engage appropriate targets, report the situation to his company commander, compensate for execution failures as well as assess the potential impact of other factors -- terrain, weather, personnel, supplies -- on mission accomplishment and unit survivability. To be able to carry out these tasks effectively and in rapid succession requires a mastery of information processing and decision making skills not likely to be found among inexperienced platoon leaders. Given the introduction of new doctrine and advanced technology which ties victory less to the fire power of mass formations and more to the ability of small units to outmaneuver and to react faster than the enemy, it is essential that platoon leaders be given extensive and repeated practice on the execution of command, control and communication procedures in a training environment which simulates the highly-fluid, rapid-paced, information-rich battlefield environment.

It is within this context that the present study seeks to identify a range of media/device combinations which could potentially satisfy the functional requirements for exposing small unit leaders to a variety of realistic tactical situations. In the previous sections of this report, a procedure was described and results were reported which summarized the extent to which media/device combinations could be expected to fulfill functional capability requirements as well as satisfy other criteria. To determine what is and what is not possible with these potential devices, a closer examination of these findings is in order.

Assessment of the Potential Devices

Devices one and two in Table 7, both with dedicated bus structures, consistently received the lowest rankings across the evaluation criteria. Both are severely limited in terms of growth potential, technical feasibility and functional capability. Because of their severely limited capability, only subsets of singular tasks might be possible and these only with a formidable amount of software development and a complete development tool system. In their present state, these devices may be useful for memory aid applications, especially the hand-held liquid crystal configuration.

The 8-bit devices, three through six in Table 7, held the next set of lowest ranks. These devices, although they vary with respect to ease of user input, voice synthesis, hard-copy and instructor monitoring as presently configured, are representative of the current wave of personal computers on the market today. Special input components and limited voice synthesis did not add much to their capability according to the

ratings. The videodisc option of device five enhances visual representation requirements but also demands additional development tools. The remaining devices are capable of providing low resolution graphic representations, however, their low level of processing power would preclude the performance of other required computational operations simultaneous with the graphics operations. Overall, devices in this group are low-cost and very modest in terms of functionality.

The next range of rankings went to the audio-visual devices (sixteen through twenty). Those that had a motion capability (devices seventeen and nineteen) received higher functional capability rankings compared to the still audio-visual devices (sixteen eighteen, and twenty) most likely as a result of their ability to represent vehicle movement, changes in terrain, battlefield cues, smoke dissipation, weapons firings and visual observation techniques. Limitations of the audio-visual devices include restricted growth potential, linear presentation of instructional material (although random access units do provide for some response-contingent branching), and limited student interactivity. The microprocessor-controlled slidetape device with multiple projectors and tachistoscopic overlays (device twenty) was considered to have some potential in overcoming these limitations as reflected in its slightly higher overall ranking in Table 11.

The 16-bit devices as a group received the next highest set of rankings. Devices seven through twelve would be capable of handling internal computational chores while providing for some form of video display. Large amounts of programming, however, would be required to make the various functions appear simultaneous. Real-time execution of leader tasks is still likely to be compromised. Device seven and nine have inadequate storage and thus excessive software costs would occur during development. Device eleven has a plasma display which would add greatly to both hardware and software development efforts. In addition, the many existing unknowns about plasma display technology detracts from its technical feasibility. In brief, the 16-bit devices are still limited with respect to expansion capability. Incremental enhancement of functional capability would be unlikely; tactical concepts developed on these systems would have to be reprogrammed on a new system when the old one is outgrown.

The highest overall rankings went to the multiple processor devices fifteen, fourteen, and thirteen in descending order. These devices offer a dedicated graphics processor which significantly reduce the complexity of performing graphics concurrently with student and instructor interaction. The hardware allows for adequate computing power thus minimizing software development costs in addition to providing sufficient display power to represent appropriate battlefield conditions and features. Design and development phases would derive added flexibility through the availability of mature supporting software packages.

The conduct of multitask tactical training in real-time becomes a more realizable goal with the last set of devices. Attempting to develop complex software on the lower-end hardware requires additional development tools and heroic amounts of programming effort. Heroic efforts are

high risk at best. Effective tactical training as envisioned in this research effort is controlled by software development to a far greater extent than may have been originally realized. To recommend to the Army anything but the top ranked devices without clearly pointing out the additional software burden would be to adopt a course of action destined to lead to cost overruns if not failure. It is for these reasons that the last set of potential devices of all those considered in this evaluation offer the minimum programming cost and development risk while adequately addressing functional requirements.

A Research and Development Strategy to Tactical Training

From the start, the study has been guided by the assumption that the acquisition of cognitive skills which underlie tactical proficiency depends less on costly weapon system simulation and more on the processing of visual and auditory information from a simulated battlefield environment. To keep costs and developmental risks within acceptable limits, Bessemer (1980) has advocated an incremental, building block approach to tactical simulation whereby low-cost, off-the-shelf microcomputer and peripheral devices can be examined for feasibility in meeting visual display, communications and control requirements. Rather than start top down with a full platoon simulation that purports to do everything, Bessemer prefers to build from the bottom up for tactical training. Once the technical problems associated with the creation of real-time, interactive visual display and communications are resolved, the complexity of the simulation can be increased by the addition of other leader stations. All of the potential devices examined above fall within the low-cost, off-the-shelf category, although the multiple microprocessor-based units are more costly items than the lower-end devices. As indicated earlier, software development effort is often overlooked and should be of primary concern when attempting to keep costs and developmental risks within acceptable limits.

Brown (1983a, 1983b) also has advocated an integrated approach to training as noted earlier in the report. Brown foresees the use of tabletop microcomputers for those tasks in which soldiers experience rapid skill decay and for which use of more elaborate and costly simulation systems (e.g., U-COFT) would be inappropriate. Low-cost, availability, and easy maintainability are three factors that make possible the use of tabletop trainers at the company level on a daily basis. By employing the same "crawl, walk, run" approach to training technology that Brown applies to field exercises, we need not unwittingly misuse valuable leading-edge technological resources for tasks that can be more appropriately trained on existing and readily available technology.

Utilization of Tactical Scenarios

An examination of Appendix A, Scenarios, reveals, in part, the complexity of the platoon leader's job. The tactical scenarios realistically depict several critical tasks. It is difficult from a casual reading, however, to fully appreciate the problems that an inexperienced platoon

leader would have in performing many of the tasks in rapid succession. To acquire a better understanding and mastery of the information processing and rapid pressure demands placed upon platoon leaders, tactical scenarios need to be utilized or experienced rather than read. In addition to providing a foundation for the development of training device functional specifications, the tactical scenarios presented here should prove useful to researchers and training developers in need of contextual material for developing either manual or automated gaming procedures at the platoon leader level. With the exception of Dunn-Kempf and BLOCKBUSTER, most of the current battle simulations provide training at battalion level and up rather than at the small unit level. Given that our present understanding of what tactical tasks lend themselves to effective training by means of microcomputer technology is based, to a large part, on conceptual analyses, empirically oriented studies are needed to demonstrate what is and what is not technically feasible. The development of accurate and realistic scenarios is always a labor intensive effort and thus an initial step has been made for eventually arriving at a "hands-on" assessment of microcomputer-based tactical training.

Utilization of Functional Descriptions

State-of-the-art microprocessor technology and continuing improvement in the variety and quality of software is rapidly making computer-based training a viable alternative to conventional modes of training. The continuing technological sophistication of equipment, the increasing recognition of the importance of embedded training, the constrained economic environment, and the interactive capability of computers are a few of the factors accounting for the impetus behind computer-based training. Expected benefits of the new technology include quality control and standardization of lesson content, shorter training cycles, enhanced student motivation, and reduced training costs.

While those in the Army research and development community with a technical orientation have eagerly embraced the use of microcomputers and their expected benefits, it is likely to be the user groups -- training developers, course designers and instructors -- that are least familiar with the new technology and its functions. The functional descriptions appearing in Appendix C provide a basic overview of microprocessor, video, and audio-visual based components and may serve as a useful primer or glossary for those individuals who are not computer specialists but who are interested in maximizing the training benefits of this new instructional technology. The representative vendors listed in Appendix C, along with each component serve as a source of contact for further technical information.

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O'Brien, R. E. & Drucker, E. H. (1983, January). Training objectives for tank platoon leaders covering tasks performed during four armor operations (HumRRO Rep. No. RP-TRD(KY)83-1). Alexandria, Va.: U.S. Army Research Institute.

APPENDIX A

SCENARIOS

APPENDIX A

SCENARIOS

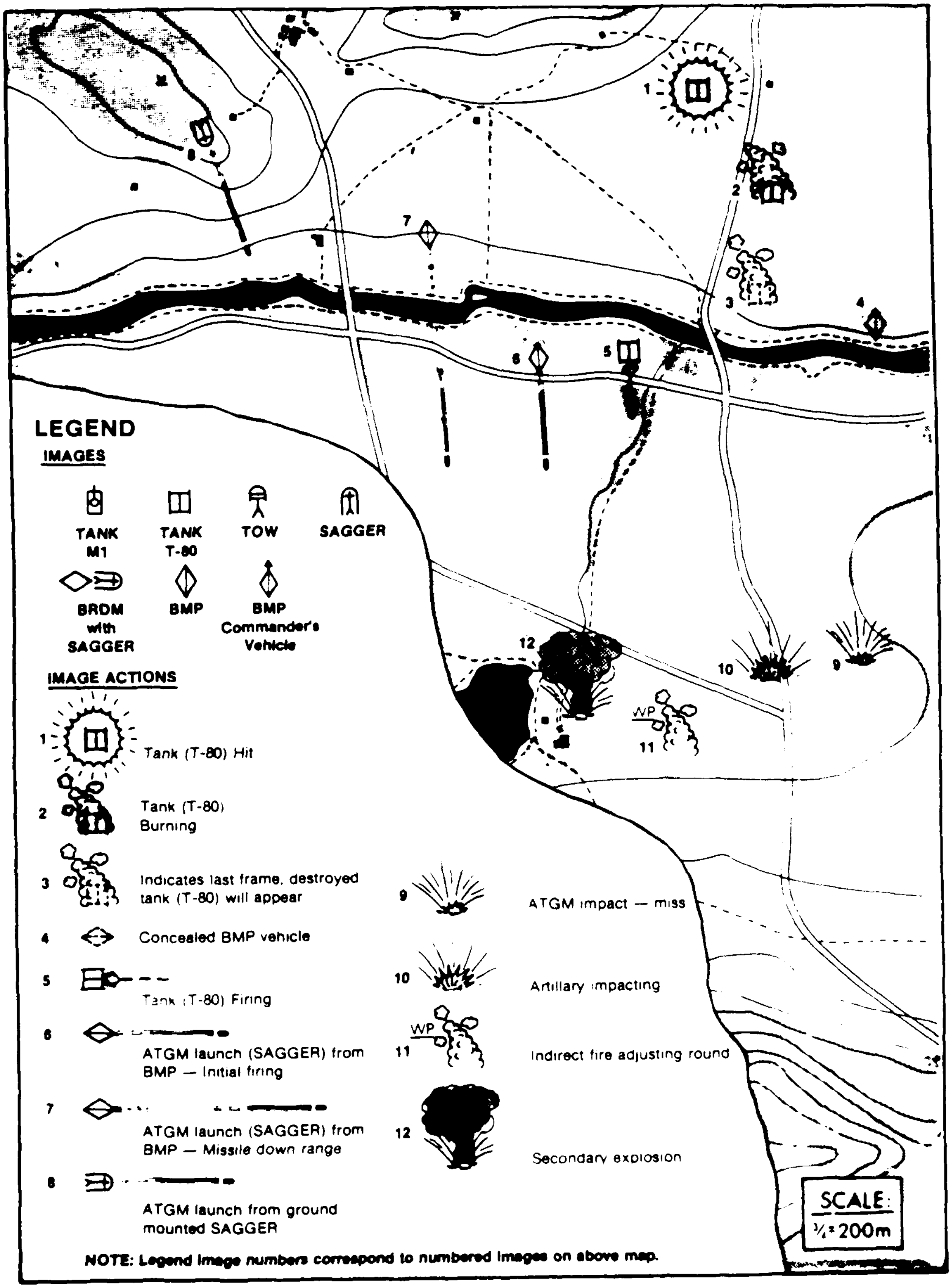
Scenario Summary

The outline below provides an overview of the four scenarios, the platoon operation involved, and the corresponding OPFOR mission.

Scenario No.	Platoon Operation	OPFOR Unit/Mission
1	Initiate Direct Fires in Platoon Sector	Combat Reconnaissance Patrol (Reinforced)/ Reconnaissance, initial contact made with US positions.
2	Initiate Direct Fires in Platoon Sector	Advance Party (Motorized Rifle Regiment/ Engage US positions and maintain contact.
3	Initiate Direct Fires in Platoon Sector	Advance Guard (Motorized Rifle Regiment)/ Reinforce Advance Party and attack US positions.
4	Immediate Action (Movement to Contact)	Rifle Platoon and Tank Section (Motorized Rifle Regiment)/Rear guard defensive action.

Scenario Legend

A legend identifying US and OPFOR vehicles, weapons, weapon firings and weapon effects for all scenarios is provided on the next page.


LEGEND
IMAGES
TANK M1
TANK T-80
TOW
SAGGER
BRDM with SAGGER
BMP
BMP Commander's Vehicle
IMAGE ACTIONS
1 Tank (T-80) Hit
2 Tank (T-80) Burning
3 Indicates last frame, destroyed tank (T-80) will appear
4 Concealed BMP vehicle
5 Tank (T-80) Firing
6 ATGM launch (SAGGER) from BMP — Initial firing
7 ATGM launch (SAGGER) from BMP — Missile down range
8 ATGM launch from ground mounted SAGGER
9 ATGM impact — miss
10 Artillary impacting
11 WP Indirect fire adjusting round
12 Secondary explosion
SCALE: ¼" = 200m
NOTE: Legend image numbers correspond to numbered images on above map.

Scenario Number One

Platoon Operation: Initiate Direct Fires in Platoon Sector

Tasks and Task Repititions

- Submits SPOTREP (4)
- Directs enemy be engaged (3)
- Requests indirect fire (1)

Scenario Introduction

You are the platoon leader of a tank platoon in a reinforced tank company/team. Your parent battalion/task force has been the lead unit on one of several axes in a division-size movement to contact. Your battalion/task force has not established contact, but others, on other axes, became heavily engaged. Your batalion task force was ordered to take advantage of favorable terrain and establish a defensive battle position west of the Blue River.

Your company/team has been assigned a center battle position and your platoon sector has been specified (see Platoon Fire Plan, page A-8). A TOW platoon will support the company team and request for TOW support to reinforce platoon fires will be coordinated through the company/team commander. Third platoon occupies the left battle position and second platoon the right.

Battalion/task force reconnaissance elements to your front were engaged in several firefights and were withdrawn. Intelligence reports indicate that the enemy will press his main attack elsewhere; enemy activity to your front is expected to be a secondary attack.

It is 1000 hours on a warm, sunny, clear day: wind is 180° at 9 knots. You moved into your position two hours ago and, following the principle of using available time to improve your position and plans, you and your platoon sergeant have accomplished the following:

- Issued frag order.
- Assigned general locations of primary and alternate positions of all tanks.
- Selected primary and alternate positions for your tank, 10.
- Checked primary and alternate positions of 11, 12, and 13, including fields of fire.
- Designated sectors of fire (see sketch).
- Prepared primary positions, including camouflage.
- Prepared range cards.
- Coordinated with platoon leaders on your left and right.
- Coordinated with FIST leader.
- Coordinated with TOW platoon leader.
- Prepared a fire plan (see sketch).
- Obtained the company team fire plan.
- Reconnoitered area for supplementary positions, selected general positions, and directed that tank commanders select specific positions.
- Checked platoon wire hot loop.
- Performed refueling and maintenance operations, and checked ammunition distribution.
- Established close-in security and air guard per platoon SOP.
- Instructed that movement between firing positions would be per platoon SOP.

Scenario Introduction (Continued)

Intra Platoon/Intra Company Communication Call Signs

Radio nets are operating per SOP, including permission to use abbreviated call signs. This is a CEOI extract for purposes of scenario development.

Company/Team Commander	BRAVO 4	YANKEE 51
First Platoon Leader - Tank 10	BRAVO 4	ROMEO 45
Tank 11	BRAVO 4	ROMEO 27
Platoon Sergeant - Tank 12	BRAVO 4	ROMEO 36
Tank 13	BRAVO 4	ROMEO 64
Section 1 (Tanks 10 and 11)		ROMEO RED
Section 2 (Tanks 12 and 13)		ROMEO BLUE
Second Platoon Leader	BRAVO 4	MIKE 29
Third Platoon Leader	BRAVO 4	GOLF 17
TOW Platoon Leader - TOW 12	CHARLIE 5	PAPA 23
FIST Chief (Fire Control Net)	ALPHA 8	CHARLIE 42

Code Words

First Platoon Sector	SALLY
Second Platoon Sector	NANCY
Third Platoon Sector	JANE
Move to defilade positions	HIDE
Am moving to alternate (different) position	TALLYHO
Am ready to fire from alternate (different) position	BINGO
Smoke	CANDY
Primary or alternate firing position	HOMEPLATE

Scenario Introduction (Continued)

Code	Authentication
BRAVO DELTA	ZULU
LIMA FOXTROT	PAPA
ROMEO JULIET	OSCAR

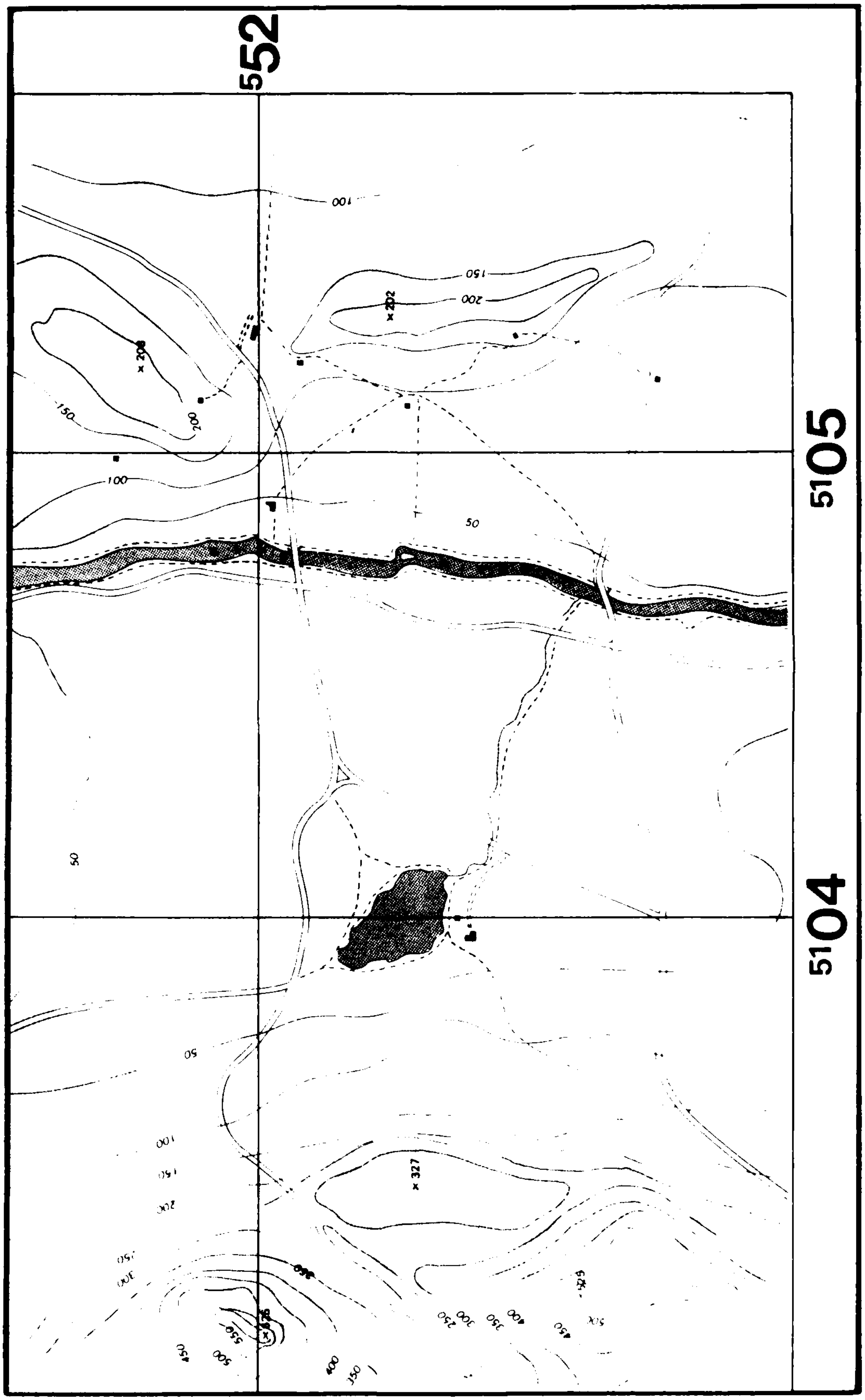
Status Report

Your company/team SOP calls for a STAREP every four hours beginning with 2400. STAREP are also required when an event occurs that could significantly affect unit status; e.g., receipt of enemy fire. STAREP format is as follows:

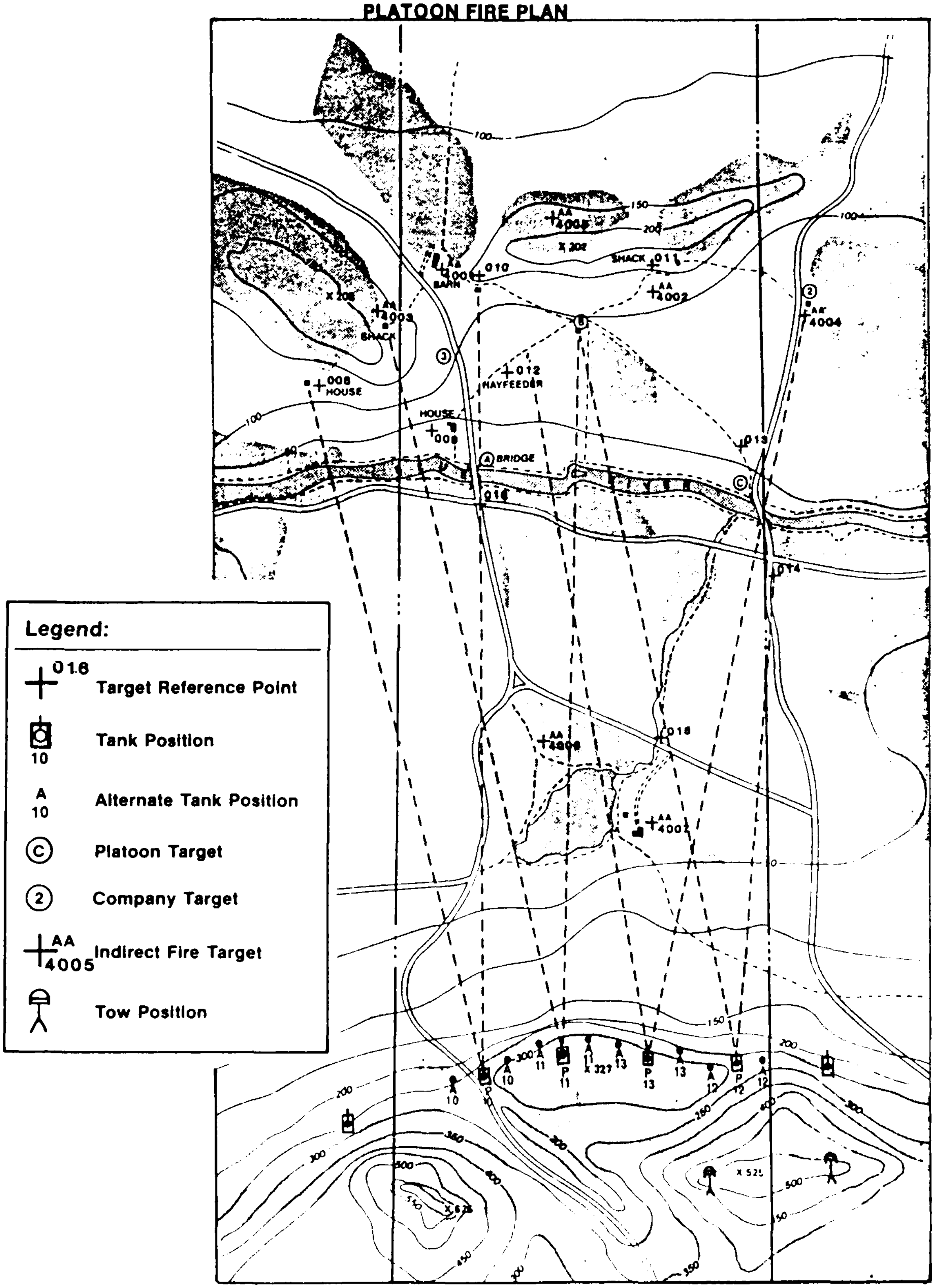
As of time

ALFA:	Reporting unit
BRAVO:	Location
CHARLIE:	Activity
DELTA:	Personnel
ECHO:	Ammunition
FOXTROT:	POL
GOLF:	Equipment
HOTEL:	Remarks

SITUATION MAP NO. 1



PLATOON FIRE PLAN



Scenario Number Two

PLATOON OPERATION: Initiate Direct Fires in Platoon Sector

Tasks and Task Repetitions:

- Directs enemy be engaged (4)
- Requests indirect fires (1)
- Requests indirect fires be adjusted (1)
- Designates targets to TOW Platoon (1)
- Request TOW Platoon reinforce platoon fire (1)
- Monitors TOWs (2)
- Submits SPOTREP (3)
- Submits STAREP (4)

Scenario Introduction

Scenario 2 is a continuation of Scenario 1. The Platoon is in a defilade (HIDE) position to avoid OPFOR ATGM. The platoon leader has requested immediate suppression on AA4002. All Call Signs and Code Words used in Scenario 1 apply to Scenario 2.

Scenario Number Three

PLATOON OPERATION: Initiate Direct Fires in Platoon Sector

Tasks and Task Repetitions:

- Direct enemy be engaged (3)
- Direct enemy be engaged with TIS (2)
- Requests indirect fires (2)
- Monitors TOWs (3)
- Submits STAREP (1)

Scenario Introduction

Scenario 3 is a continuation of Scenario 2. The first platoon is receiving the weight of an attack by the Advance Guard of a Motorized Rifle Regiment. The platoon leader has submitted a STAREP informing the company commander the results of the latest contact and the current OPFOR size and activity. All Call Signs and Code Words used in Scenarios 1 and 2 apply to Scenario 3.

Scenario Number Four

PLATOON OPERATION: Immediate Action

Tasks and Task Repetitions:

- Directs smoke be popped (1)
- Directs movement into defilade position (1)
- Submits SPOTREP (1)
- Directs enemy be engaged (1)
- Request indirect fires (1)
- Request indirect fires be adjusted (1)

Scenario Introduction

You are the platoon leader of a tank platoon in a reinforced tank company/team. Your parent battalion/task force is the lead unit on one of several axes in a division-size exploitation following a successful counterattack. Your parent unit has been engaged with a motorized rifle regiment which has been conducting a delaying action. Despite aggressive pursuit by your battalion/task force, the enemy has managed, under cover of darkness, to break contact. You are the lead element of your reinforced company/team which has the mission of regaining contact and continuing the exploitation.

It is 0730 on a clear, autumn day. Wind is 180 at 3 knots. Your platoon has been refueled and resupplied with ammunition. You have not met any organized resistance for several hours. You are under no engagement restrictions.

You observe that the terrain between the built-up area and the high ground to the East offers little cover and concealment and request that BRAVO 4 GOLF take up an overwatch position to support ROMEO's movement beyond the built-up area. BRAVO 4 GOLF 17 has reported that GOLF is "SET". You have ordered ROMEO to move out from covered and concealed positions in the built-up area and are moving in wedge formation about 100 meters East of the built-up area.

Scenario Introduction (Continued)

Intra Platoon/Intra Company Communication Call Signs

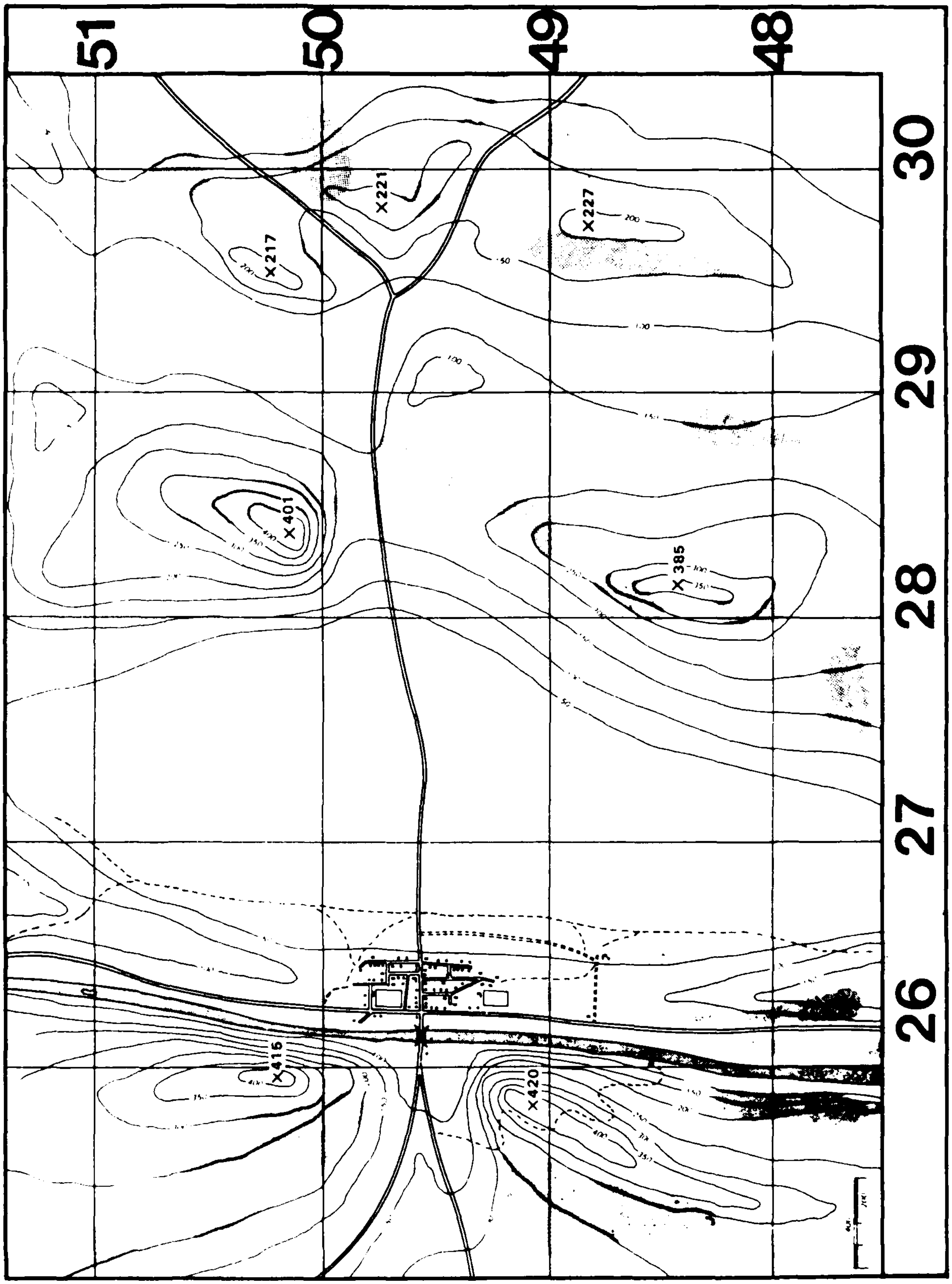
Radio nets are operating per SOP, including permission to use abbreviated call signs. This is a CEOI extract for purposes of scenario development.

Company/Team Commander	BRAVO 4	YANKEE 51
First Platoon Leader - Tank 10	BRAVO 4	ROMEO 45
Tank 11	BRAVO 4	ROMEO 27
Platoon Sergeant - Tank 12	BRAVO 4	ROMEO 36
Tank 13	BRAVO 4	ROMEO 64
Section 1		ROMEO RED
Section 2		ROMEO BLUE
FIST Chief (Fire Control Net)	ALPHA 8	CHARLIE 42

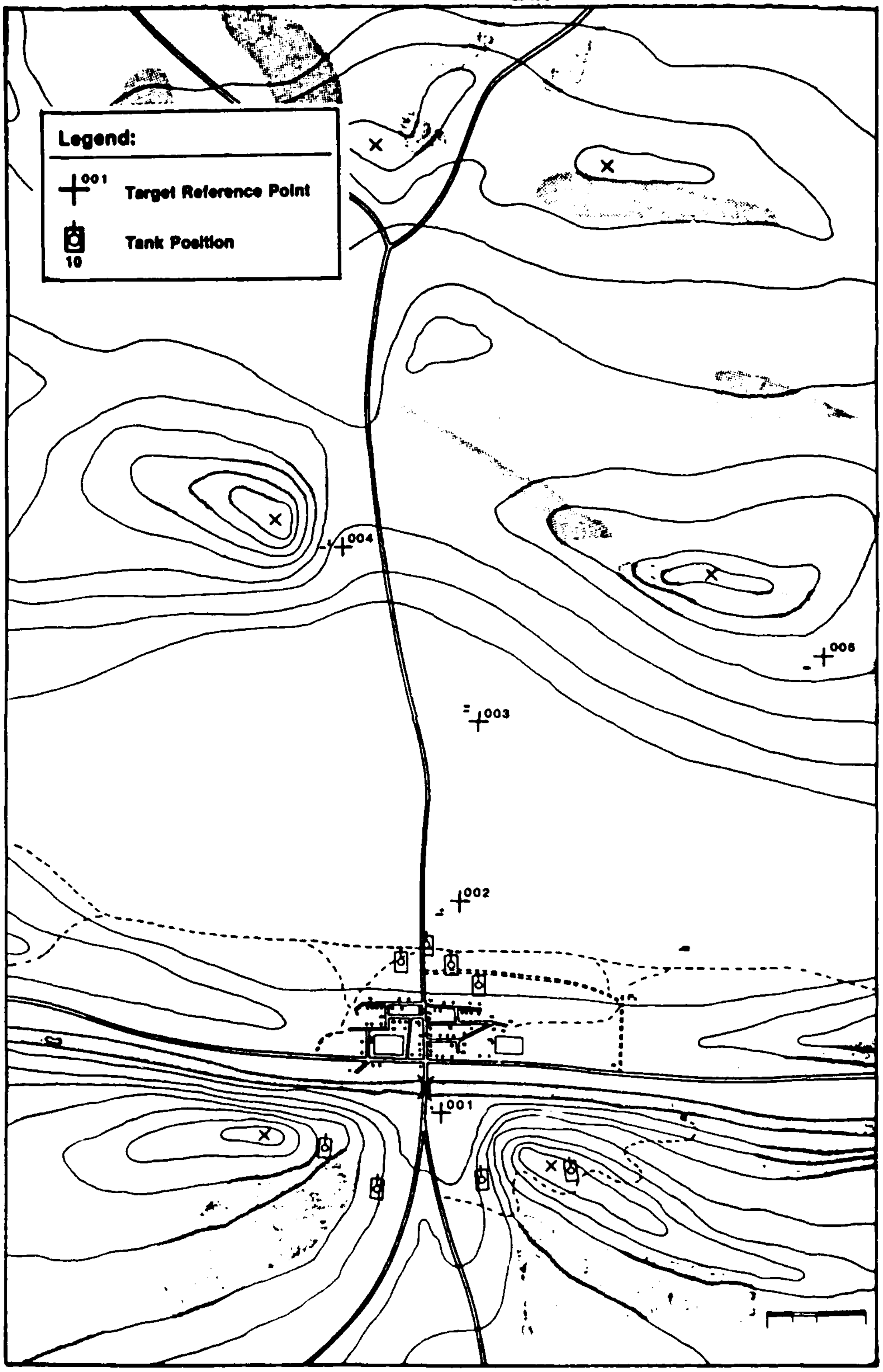
Following platoon	BRAVO 4	GOLF 17
Following company/team	CHARLIE 6	ZULU 23
Battalion/Task Force Commander	ECHO 6	MIKE 21

Code	Authentication
MIKE DELTA	XRAY

SITUATION MAP NO. 2



PLATOON FIRE PLAN



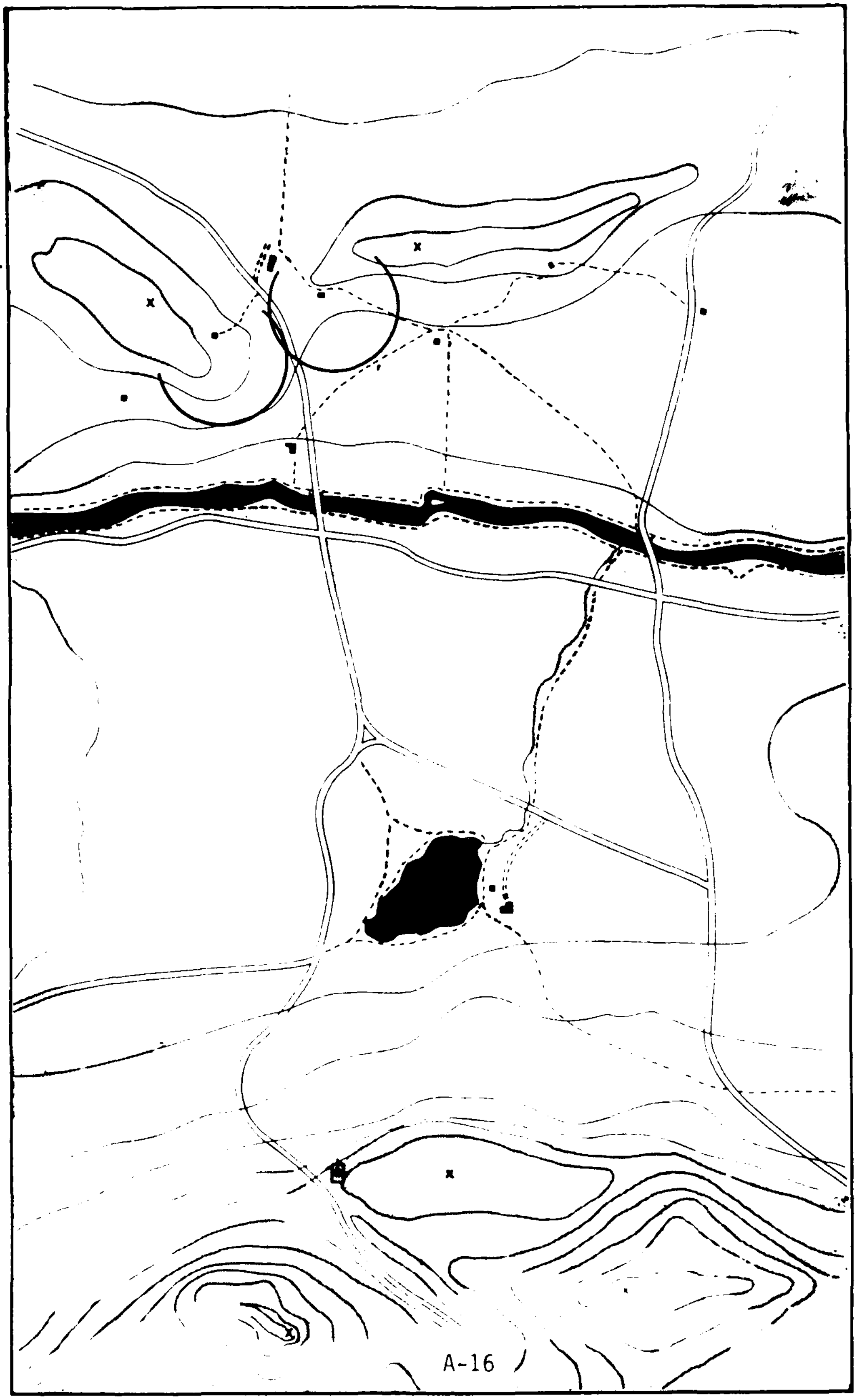
Scenario 1

Frame: 1

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	00	ON PLATOON NET	PLATOON LEADER SEARCHES OWN SECTOR.
Platoon Sergeant observes BMPs moving SW vicinity TRP 011.	10 - 10	1. "ROMEO 45 - THIS IS ROMEO 36. TWO BRAVO MIKE PAPAs, VICINITY ZERO ONE ONE MOVING TOWARD TARGET BRAVO. BLUE WILL ENGAGE - OVER."	

Frame: 1

SCALE:
¾ = 200m



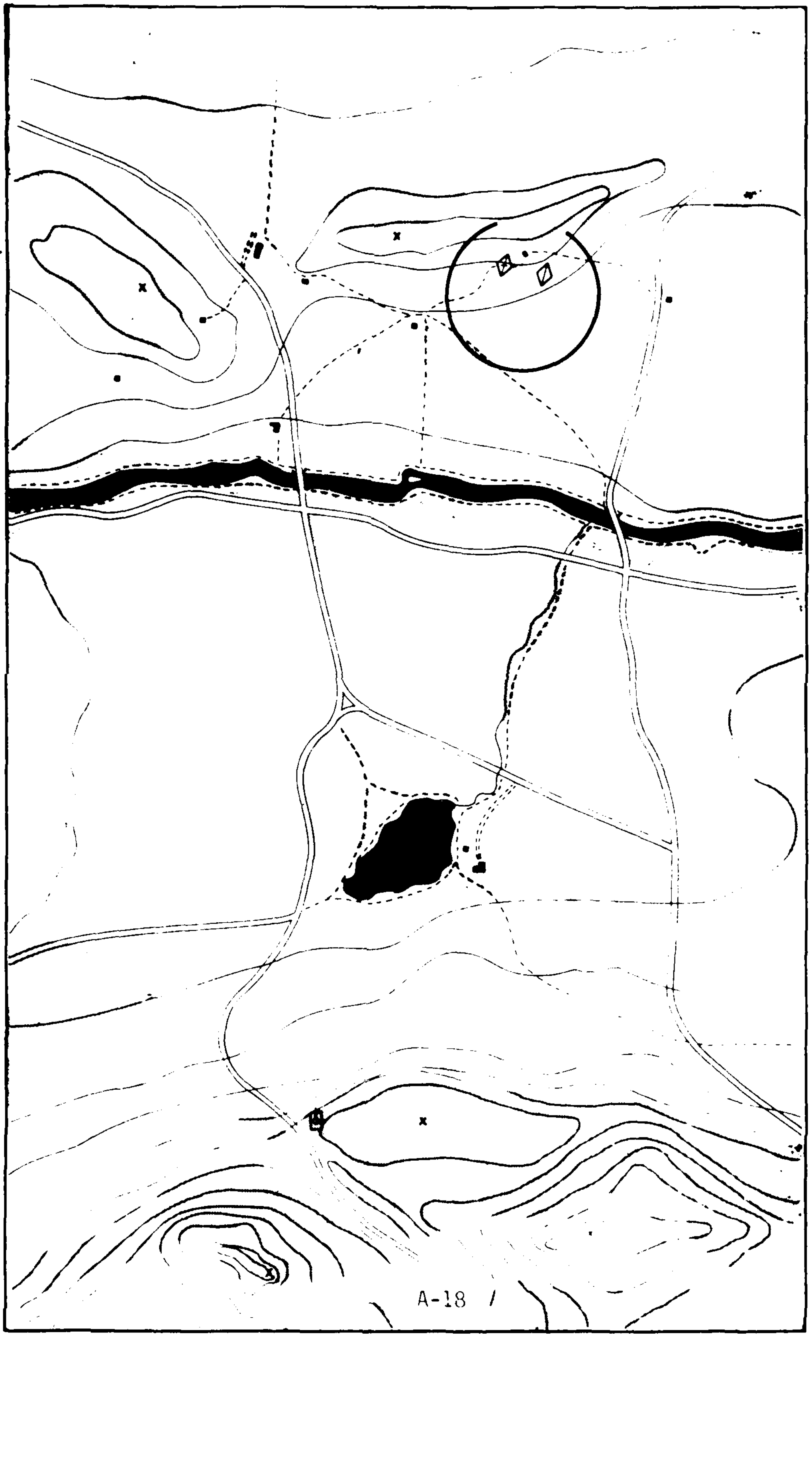
GO TO
THE NEXT
FRAME

Scenario 1 **Frame: 2**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	10 - 10		2. PLATOON LEADER ACQUIRES TARGET WITH BINOCULARS.
			ON PLATOON NET
	5 - 15		3. "ROMEO 36 - THIS IS ROMEO 45. ROGER - OUT - BREAK."
			ON COMPANY NET
	5 - 20		4. "YANKEE 51 - THIS IS ROMEO 45. SPOT REPORT - OVER."
		ON COMPANY NET	
	5 - 25	5. "THIS IS YANKEE 51 - OVER."	

Frame: 2

SCALE:
¼=200m



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THE NEXT
FRAME

Scenario 1 **Frame: 3**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	5 - 25	NON VOICE AUDIO	
		Sound of firing tanks.	
	10 - 35		6. "THIS IS ROMEO 45 - TWO BRAVO MIKE PAPAS MOVING SOUTHWEST VICINITY ALPHA ALPHA FOUR ZERO ZERO TWO. TIME ____. ENGAGING - OVER."
	5 - 40	7. "THIS IS YANKEE 51 - ROGER - OUT."	

Frame: 3

SCALE:
¾=200m

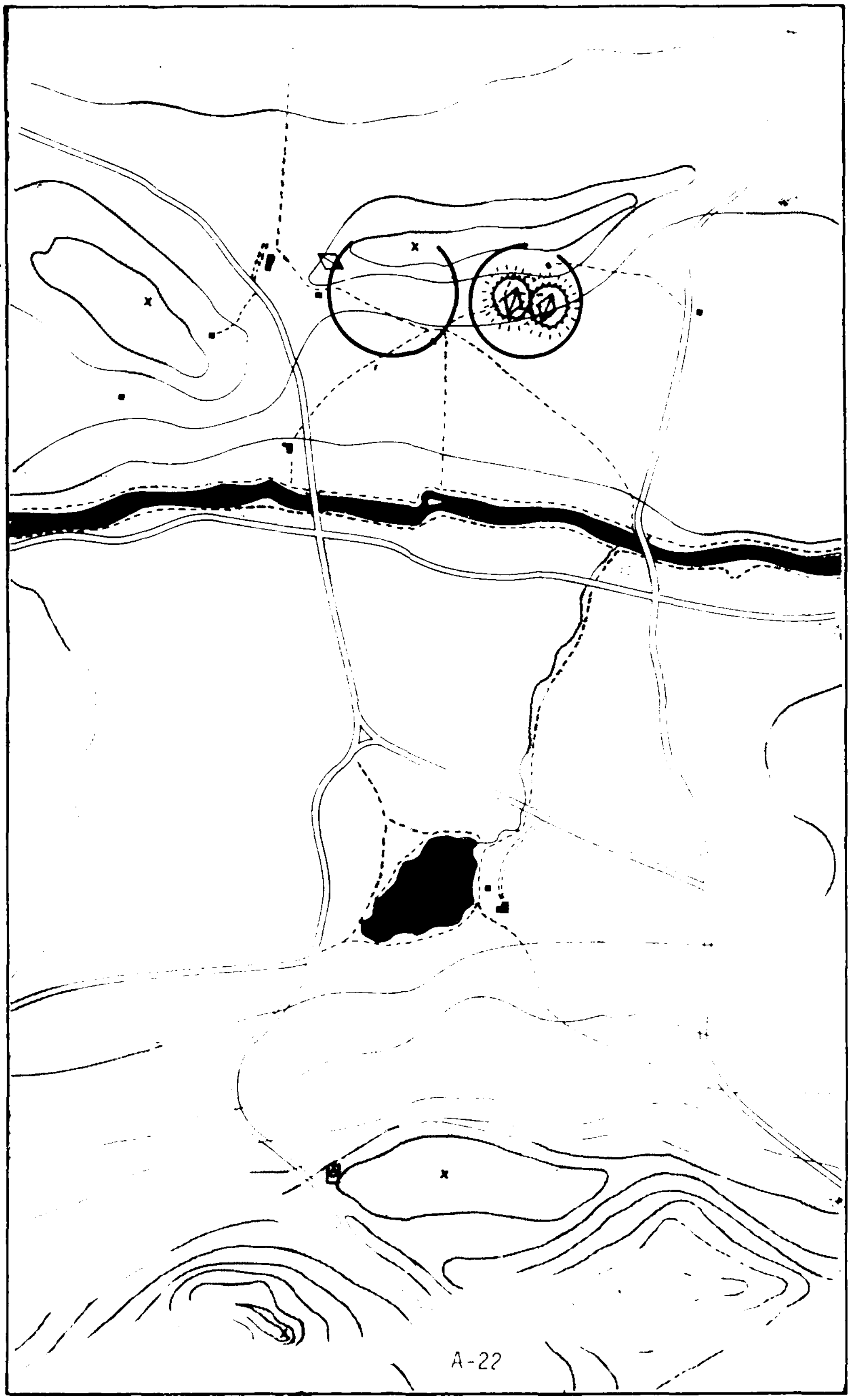
GO TO
THE NEXT
FRAME

Scenario 1 **Frame: 4**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	5 - 45	Platoon leader observes: • ROMEO 36 and ROMEO 64 achieve hits and two BMPs are stopped and burning.	8. STUDENT OBSERVES TARGET AREA (BINOCULARS)
		ON PLATOON NET	
	5 - 45	9. "ROMEO 45 - THIS IS ROMEO BLUE. TARGETS DESTROYED. TALLY HO-OUT."	
	15 - 60		10. STUDENT SEARCHES TARGET AREA (BINOCULARS).
		DISPLAY	ON PLATOON NET
	10 - 70	Platoon leader observes: • A third BMP moving south west through the gap in the trees in the vicinity of TRP 010.	11. "ROMEO 27 - THIS IS ROMEO 45. MOVING PC (PAPA CHARLIE) DIRECT FRONT - LINE OVER ZERO ONE ZERO. FIRE. BREAK."

Frame: 4

SCALE:
¾"=200m



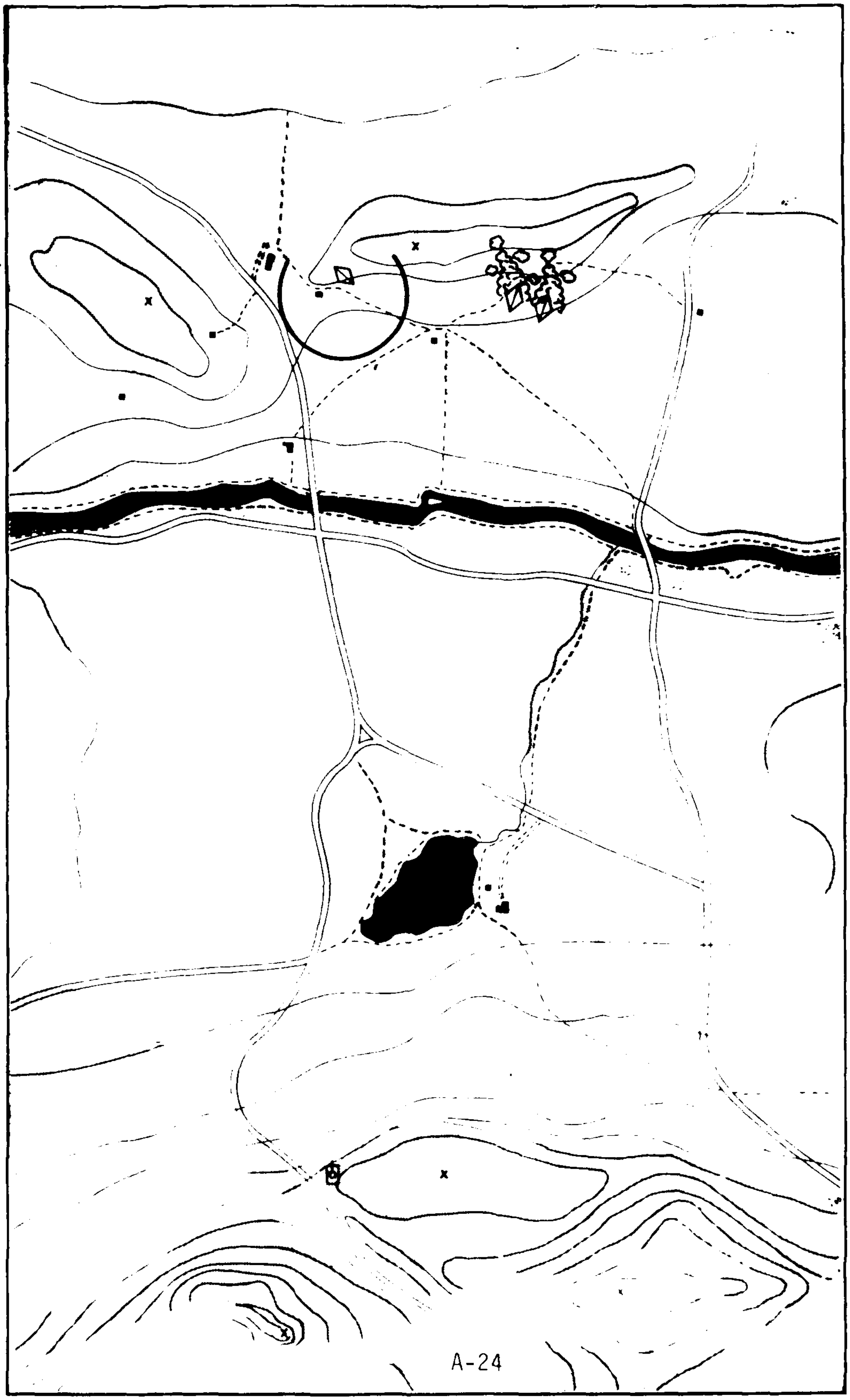
GO TO
THE NEXT
FRAME

Scenario 1 **Frame: 5**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON COMPANY NET
	5 - 75		12. "YANKEE 51 - THIS IS ROMEO 45. SPOT REPORT - OVER."
		ON COMPANY NET	
	5 - 80	13. "THIS IS YANKEE 51 - OVER."	
	15 - 85		14. "BRAVO MIKE PAPAS VICINITY ALPHA ALPHA ZERO ZERO TWO DESTROYED - BREAK. ONE BRAVO MIKE PAPA MOVING WEST VICINITY ALPHA ALPHA FOUR ZERO ZERO FIVE. ENGAGING - OVER."
		NON VOICE AUDIO	
	85 - 95	Sound of tank firing.	
		ON COMPANY NET	
	5 - 90	15. "THIS IS YANKEE 51 - ROGER - OUT."	

Frame: 5

SCALE:
¾"=200m



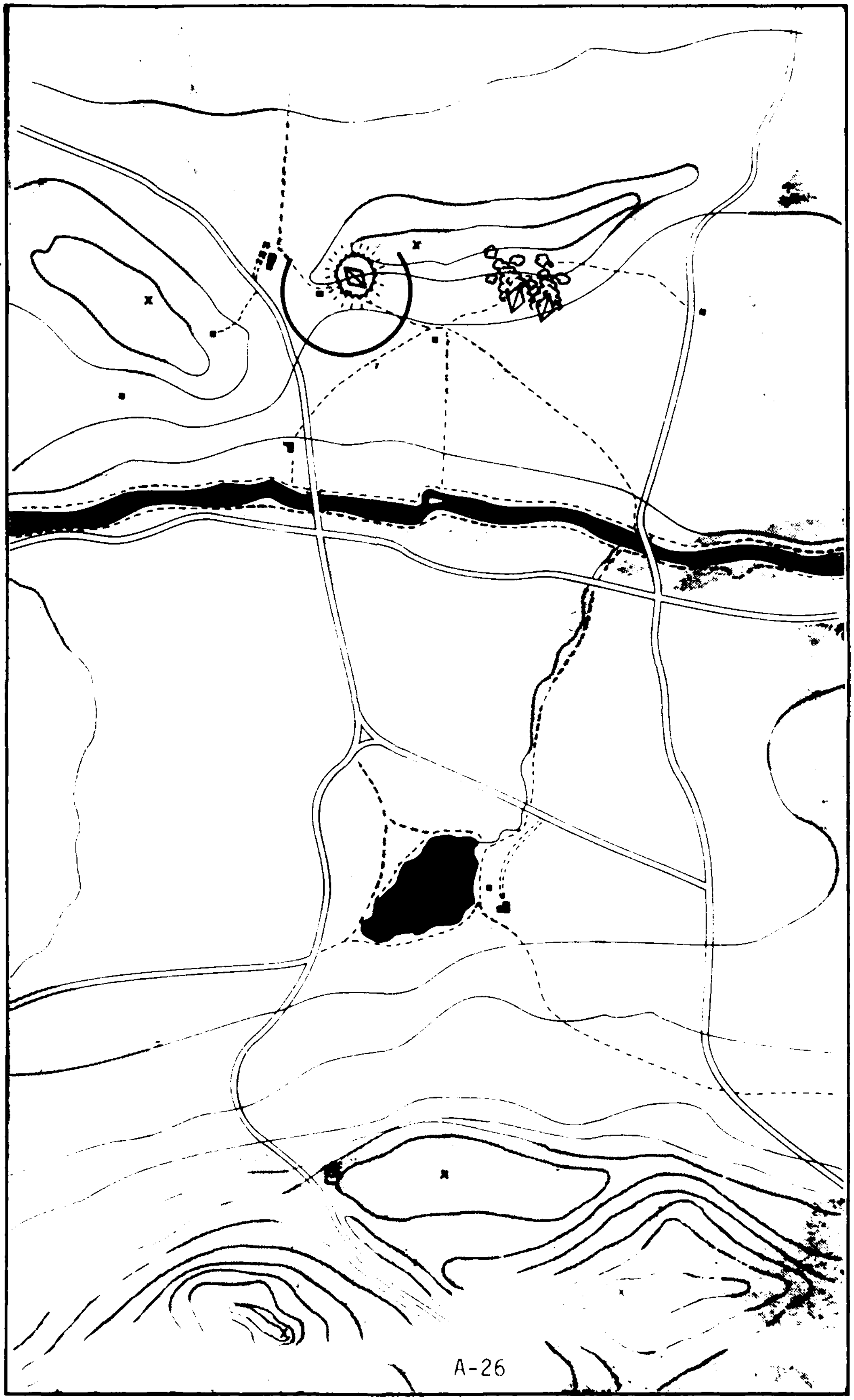
GO TO
THE NEXT
FRAME

Scenario 1 **Frame: 6**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	5 - 95	Platoon leader observes: ROMEO 27 achieves a 2nd round hit: the BMP stops and begins to burn.	16. PLATOON LEADER OBSERVES TARGET AREA - CONTINUES SEARCH (BINOCULARS).
		ON PLATOON NET	
	5 - 95	17. "ROMEO 45 - THIS IS ROMEO BLUE. BINGO - OUT."	
	5 - 100	18. "ROMEO 45 - THIS IS ROMEO 27. TARGET DESTROYED. TALLY HO - OUT."	
		ON COMPANY NET	ON COMPANY NET
	5 - 105		19. "YANKEE 51 - THIS IS ROMEO 45. SPOT REPORT - OVER."
	5 - 110	20. "THIS IS YANKEE 51- OVER."	
	10 - 120		21. "BRAVO MIKE PAPA VICINITY ALPHA ALPHA FOUR ZERO ZERO FIVE DESTROYED. TIME ___ - OVER."
	5 - 125	22. "THIS IS YANKEE 51 - ROGER - OUT."	

Frame: 6

SCALE:
¾=200m



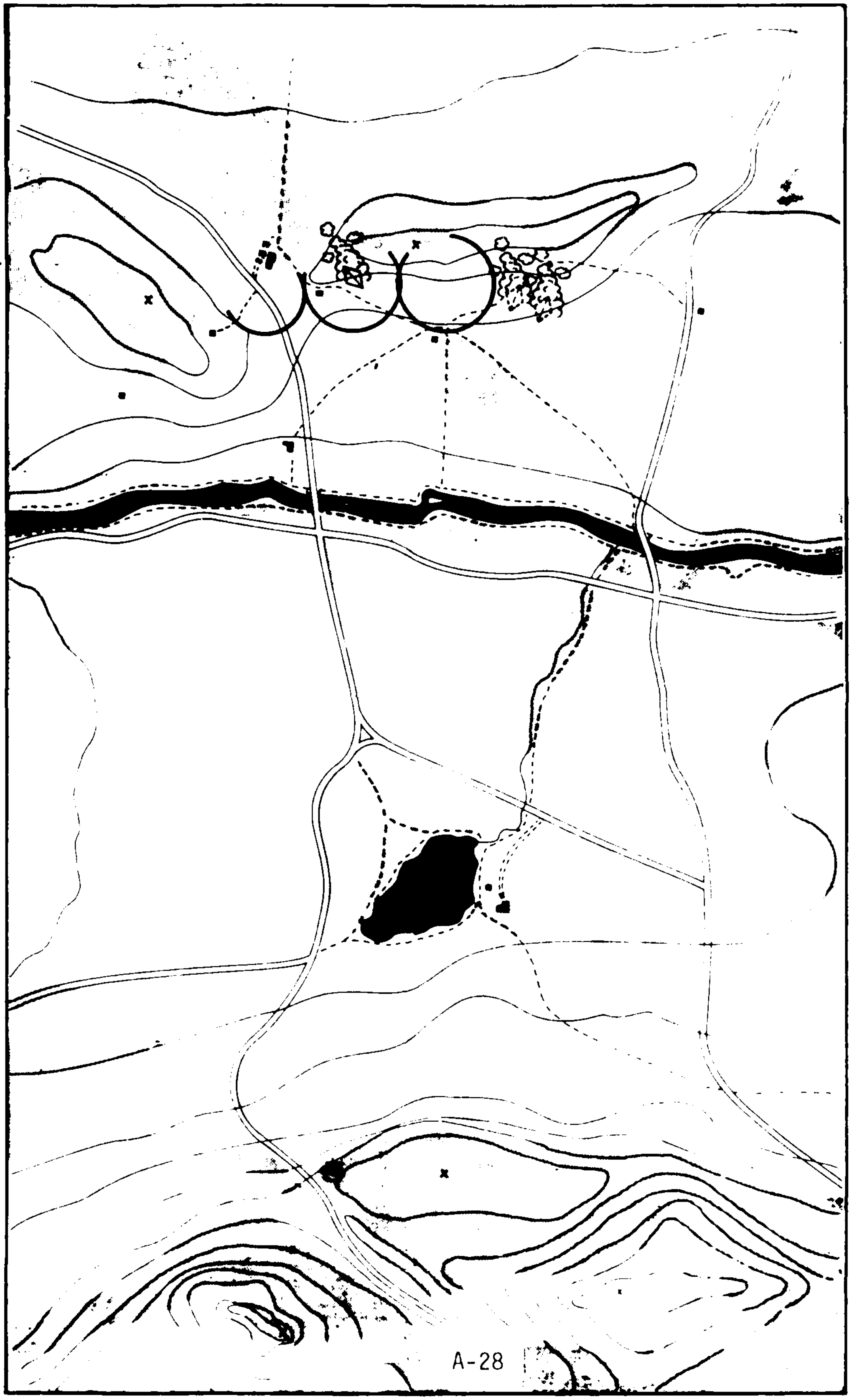
GO TO
THE NEXT
FRAME

Scenario 1 **Frame: 7**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	15 - 140	ON PLATOON NET	23. PLATOON LEADER CONTINUES TO SEARCH TARGET AREA (BINOCULARS).
	5 - 145	24. "ROMEO 45 - THIS IS ROMEO 27. BINGO - OUT."	

Frame: 7

SCALE:
¾"=200m



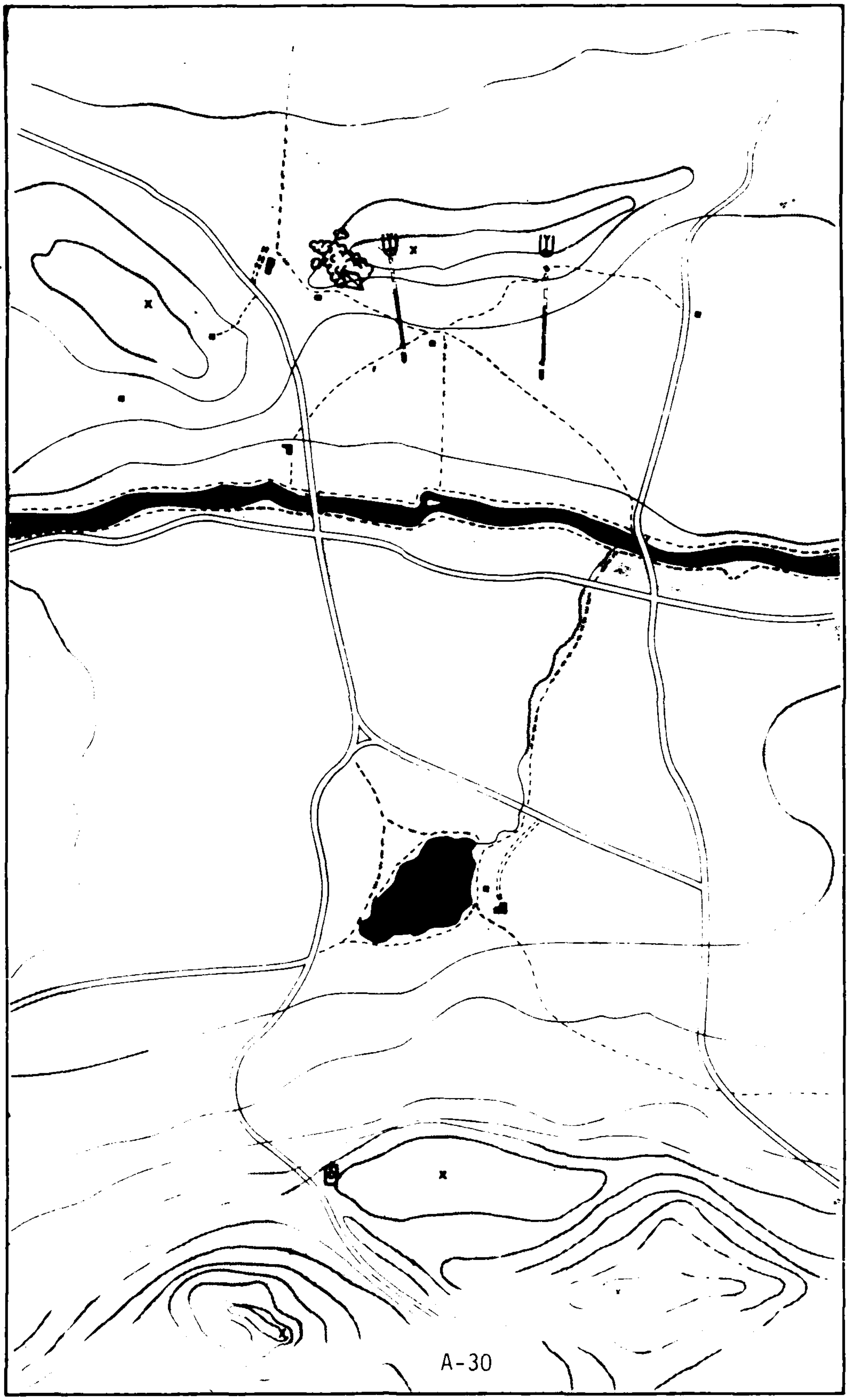
GO TO
THE NEXT
FRAME

Scenario 1 **Frame: 8**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		<u>DISPLAY</u>	
	2 - 147	Platoon leader observes: • Two ATGMs fired simultaneously from the vicinity of AA4002.	24. PLATOON LEADER CONTINUES SEARCH OF TARGET AREA (BINOCULARS). <u>ON PLATOON NET</u>
	3 - 150		25. "ROMEO - THIS IS ROMEO 45. HIDE OUT." <u>ON INTERCOM</u>
	3 - 153		26. "DRIVER-BACK UP."

Frame: 8

SCALE:
¼"=200m



GO TO
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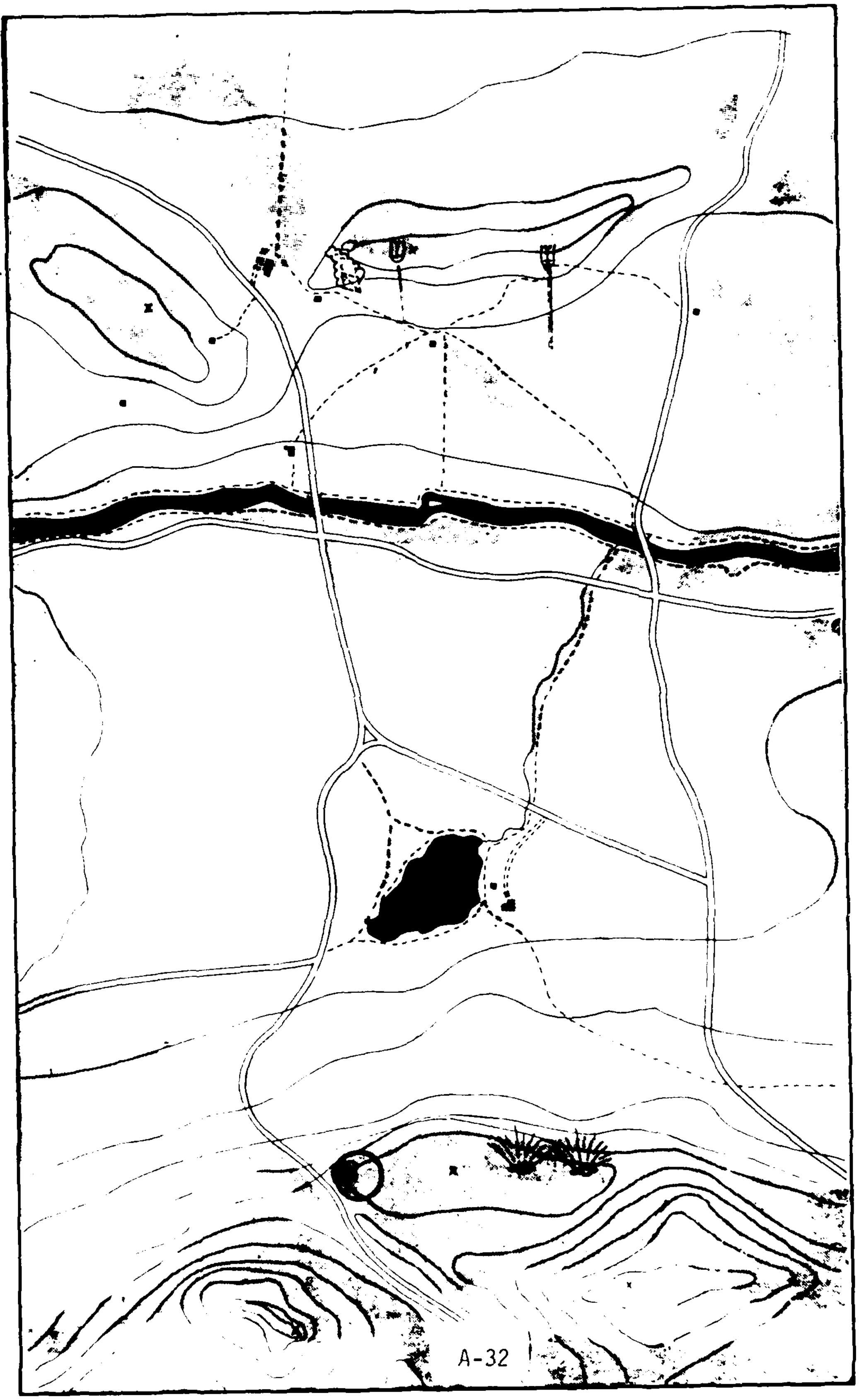
FRAME

Scenario 1 Frame: 9

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
Platoon leader's tank reaches defilade (HIDE) position.	7 - 160	DISPLAY	
	3 - 163	Platoon leader no longer has observation of defensive sector.	27. "DRIVER - STOP."
		NON VOICE AUDIO	
	3 - 166	Platoon leader hears explosions in ROMEO BLUE's area.	
			ON FIRE CONTROL NET
	7 - 173		28. "ALPHA 8 CHARLIE 42 - THIS IS BRAVO 4 ROMEO 45. IMMEDIATE SUPPRESSION ALPHA ALPHA FOUR ZERO ZERO TWO - OVER."
		ON FIRE CONTROL NET	
	5 - 173	29. "THIS IS ALPHA 8 CHARLIE 42 - IMMEDIATE SUPPRESSION ALPHA ALPHA FOUR ZERO ZERO TWO - OUT."	
			ON PLATOON NET
	5 - 183		30. "ROMEO - THIS IS 45 REPORT - OVER."
		ON PLATOON NET	
	10 - 193	31. "45 - THIS IS 27. READY IN HIDE - OUT." "36 - SAME - OUT." "64 - SAME - OUT."	

Frame: 9

SCALE:
¾"=200m



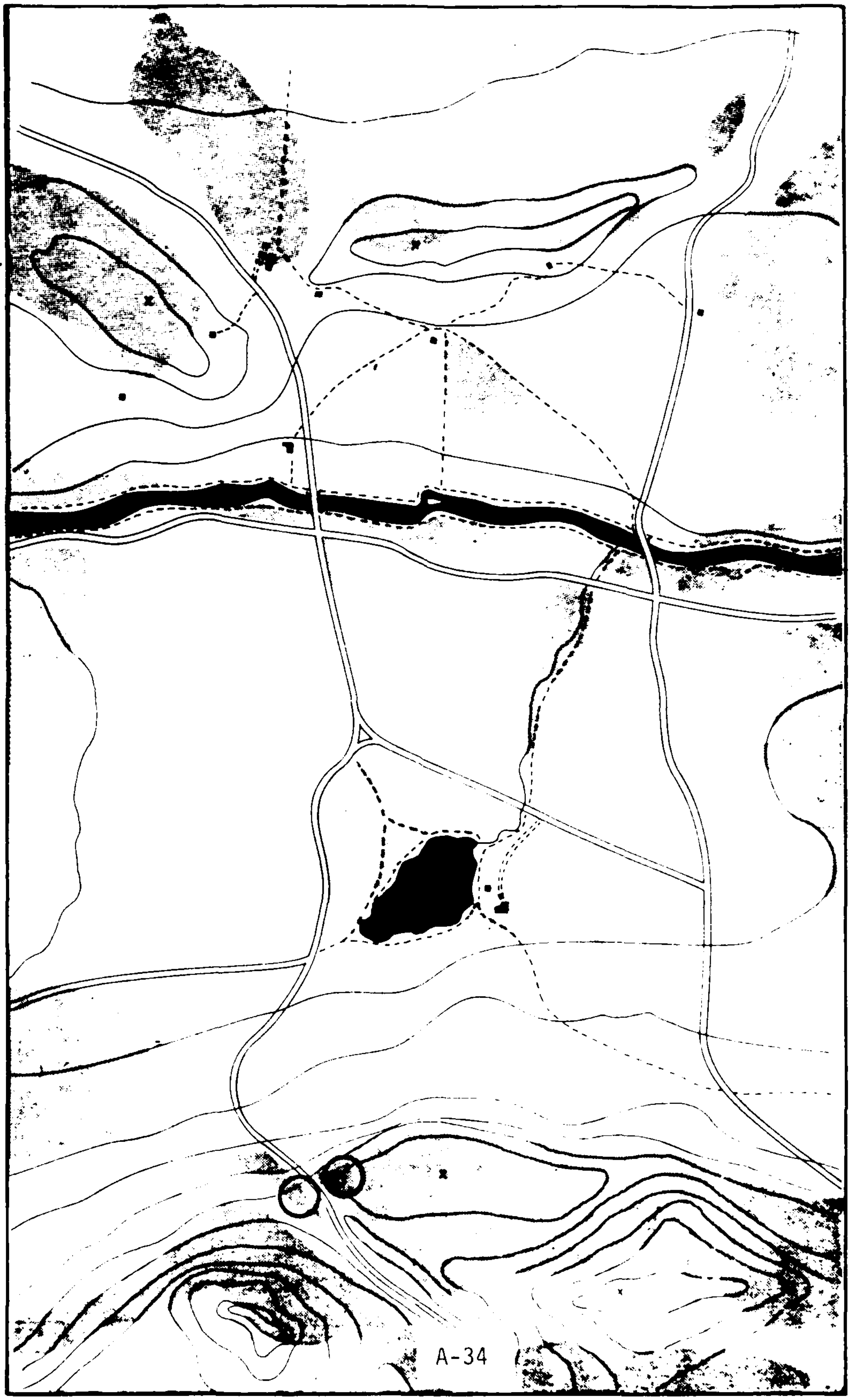
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 1**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON COMPANY NET
	5 - 5		1. "YANKEE 51 - THIS IS ROMEO 45. STAREP - OVER."
		ON COMPANY NET	
	5 - 10	2. "THIS IS YANKEE 51 - OVER."	
	30 - 40		3. "THIS IS ROMEO 45. TIME LINE CHARLIE - TWO ALPHA TANGO GOLF MIKES LAUNCHED VICINITY ALPHA ALPHA FOUR ZERO ZERO TWO. ALPHA 8 CHARLIE 42 WILL SUPPRESS. ROMEO IN HIDE. WILL TALLYHO ON CHARLIE 42'S FIRE. WILL REPORT BINGO. ALL OTHER LINES - NO CHANGE - OVER."
	5 - 45	4. "THIS IS YANKEE 51. ROGER OUT."	
		ON FIRE CONTROL NET	
	5 - 50	5. "BRAVO 4 ROMEO 45 - CHARLIE 42. SHOT OUT."	
		NON VOICE AUDIO	
	15 - 65	Sound of impacting artillery 1600 meters away.	
			ON PLATOON NET
	5 - 70		6. "ROMEO - THIS IS 45. TALLYHO - OUT."
			ON INTERCOM
			7. "DRIVER - MOVE OUT."
Platoon leader's tank moving to new firing position.	90 - 160	DISPLAY Platoon leader does not have observation of defensive sector.	

S2 Frame:1

SCALE:
¾"=200m



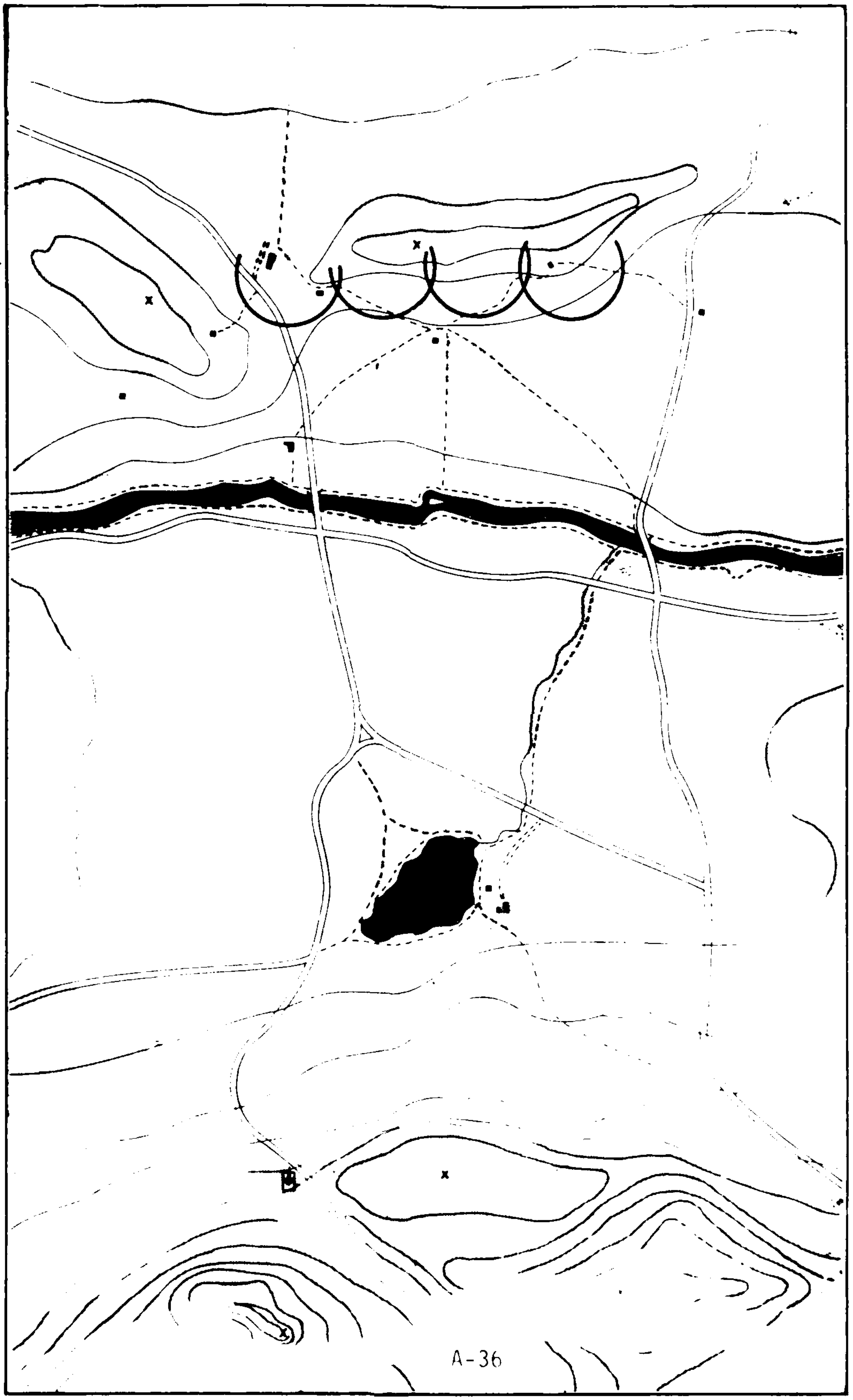
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 2**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON INTERCOM
Platoon leader's tank arrives at new firing position.	3 - 163		8. "DRIVER - STOP."
	5 - 168	9. "45 - THIS IS 27. BINGO - OUT."	
	5 - 173	10. "45 - 36. BINGO OUT."	ON COMPANY NET
	5 - 178	11. "45 - 64. BINGO OUT."	
	5 - 183		12. "YANKEE 51 - THIS IS ROMEO 45. BINGO - OVER."
	5 - 188	13. "THIS IS YANKEE 51 - ROGER OUT."	
			PL OBSERVATION - BINOCULARS
	90 - 273		14. PLATOON LEADER OBSERVES IMPACT AREA FOR FURTHER ENEMY MOVEMENT - THEN SEARCHES OWN SECTOR.

Frame: 2

SCALE:
¾=200m



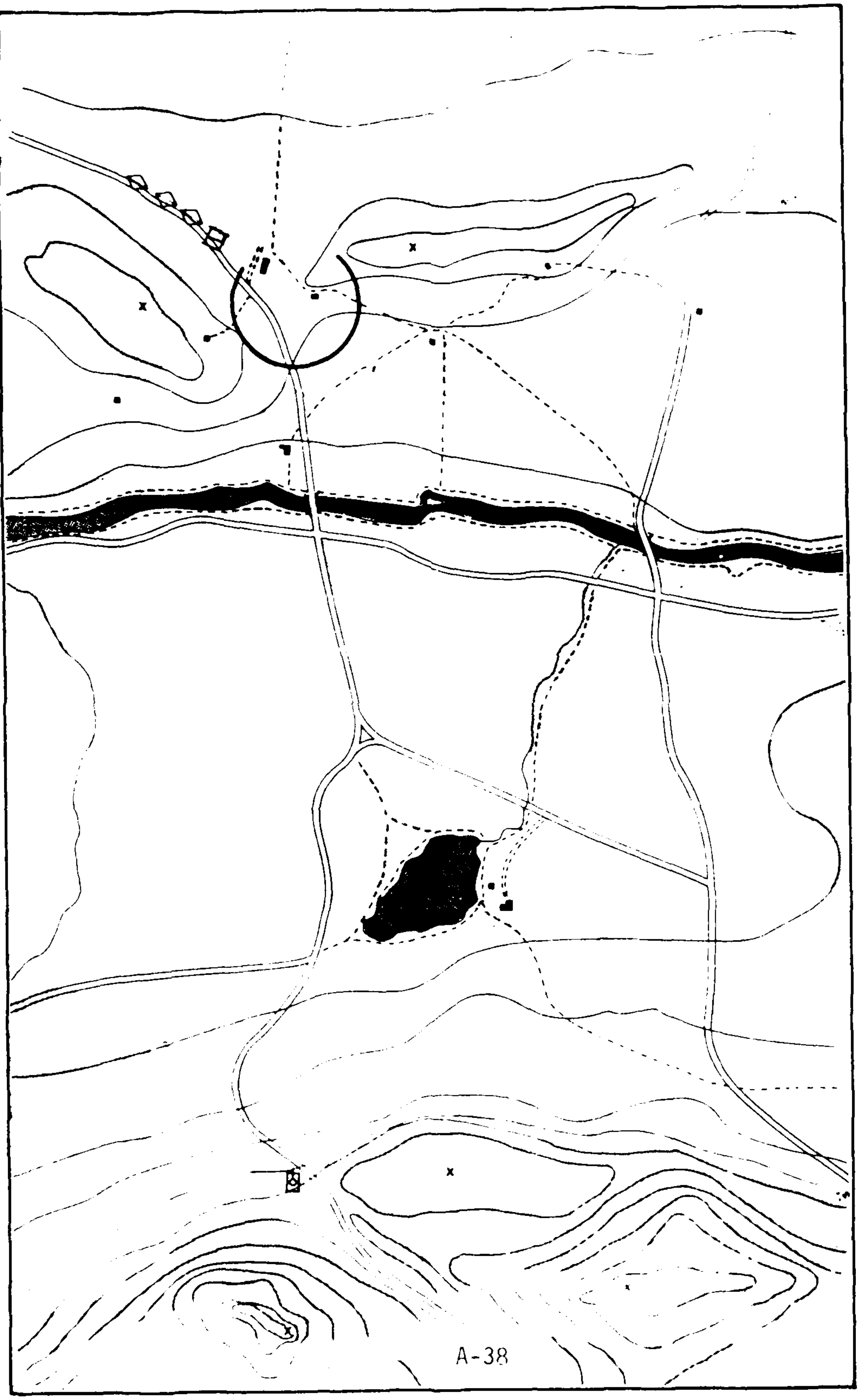
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 3**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		ON PLATOON NET	
	25 - 303	15. "ROMEO 45 - THIS ROMEO 27. THREE BRAVO MIKE PAPAS AND ONE TANGO EIGHTY MOVING INTO WOODLINE ONE HUNDRED MIKES EAST OF ALPHA ALPHA FOUR ZERO ZERO ONE - OVER."	
			ON PLATOON NET
	5 - 308		16. "ROMEO 27 - THIS IS 45. ROGER - OUT"
			ON COMPANY NET
	5 - 313	ON COMPANY NET	17. "YANKEE 51 - THIS IS ROMEO 45. SPOTREP - OVER."
	5 - 318	18. "THIS IS YANKEE 51 - OVER."	
	22 - 345		19. "THIS IS ROMEO 45. THREE BRAVO MIKE PAPAS AND ONE TANGO EIGHTY MOVING INTO WOODLINE ONE HUNDRED MIKES EAST OF ALPHA ALPHA FOUR ZERO ZERO ONE. TIME NOW ___. WILL ADJUST CHARLIE 42 - OVER."
	5 - 345	20. "THIS IS YANKEE 51. ROGER OUT."	

Frame: 3

SCALE:
¾=200m



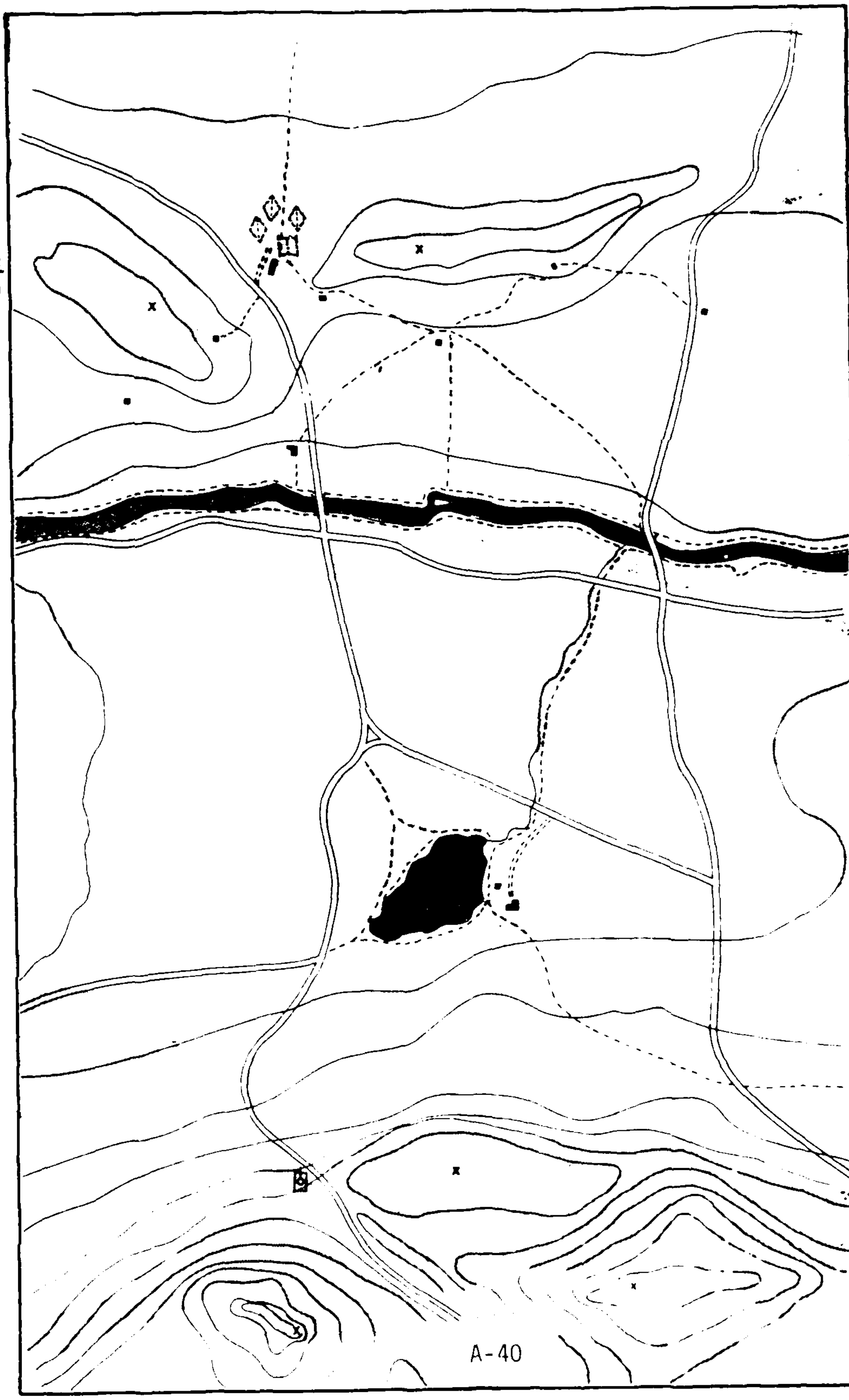
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 4

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON FIRE CONTROL NET
			21. "ALPHA 8 CHARLIE 42 - THIS IS BRAVO 4 ROMEO 45. ADJUST FIRE. SHIFT ALPHA ALPHA FOUR ZERO ZERO ONE - OVER."
		ON FIRE CONTROL NET	
	15 - 375	22. "THIS IS ALPHA 8 CHARLIE 42. ADJUST FIRE. SHIFT ALPHA ALPHA ZERO ZERO ONE-OVER."	
	10 - 385		23. "DIRECTION ONE SIX HUNDRED. ADD TWO HUNDRED - OVER."
	10 - 395	24. "DIRECTION ONE SIX HUNDRED ADD TWO HUNDRED - OVER."	
	5 - 400		25. "PAPAs CHARLIES AND TANK IN WOODLINE - OVER."
	10 - 410	26. "PAPA CHARLIES AND TANK IN WOODLINE AUTHENTICATE LIMA FOXTROT - OVER."	
	5 - 415		27. "I AUTHENTICATE PAPA - OVER."
Fire mission working.	100 -515		
	5 - 520	28. "ROMEO 45 - SHOT - OVER."	
	5 - 525		29. "SHOT - OUT."
Rounds on the way.	25 - 550		

Frame: 4

SCALE:
¾"=200m



GO TO
THE NEXT
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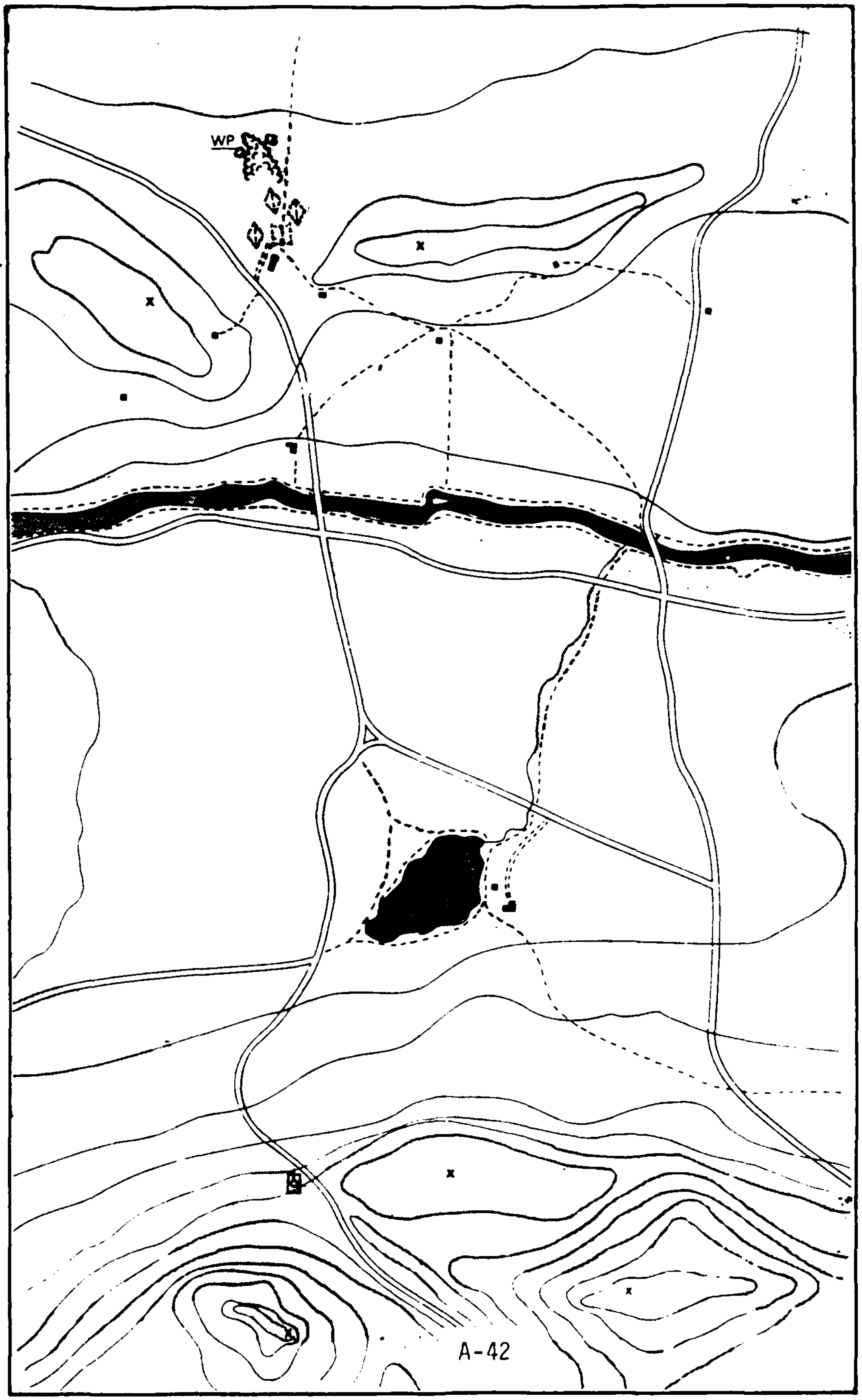
Scenario 2 **Frame: 5**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	5 - 555	Platoon leader observes: ● Adjusting round impacts 100 meters above target.	30. PLATOON LEADER OBSERVES TARGET AREA (BINOCULARS). "CHARLIE 42 - ZERO. DROP ONE HUNDRED - OVER."
		ON FIRE CONTROL NET	
	5 - 560	31. "DROP ONE HUNDRED - OUT."	
Fire mission working.	60 - 620		32. PLATOON LEADER OBSERVES TARGET AREA (BINOCULARS).

Frame: 5

SCALE:
¾=200m



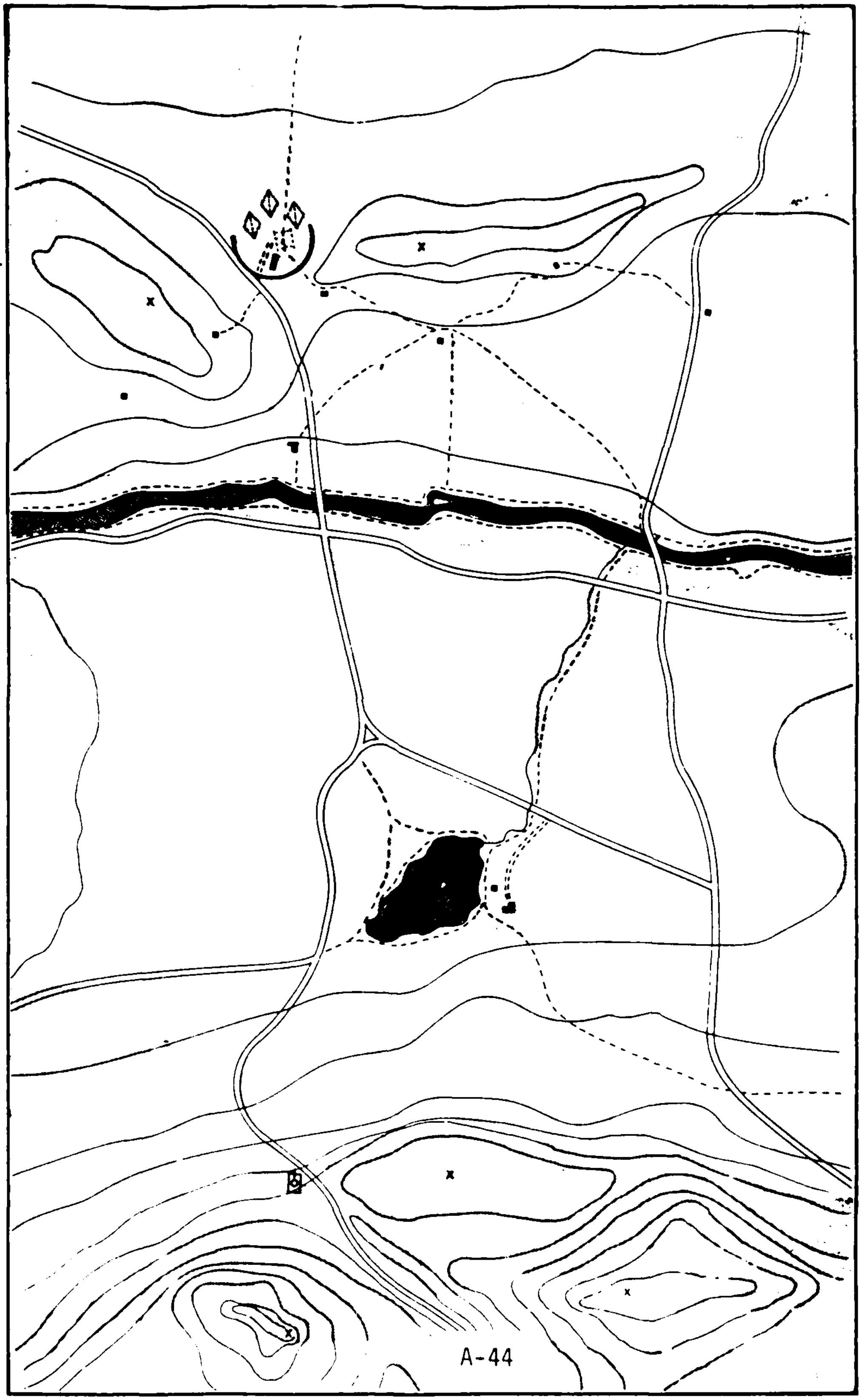
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 6

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	5 - 625	33. "ROMEO 45 - SHOT - OVER."	
	5 - 630		34. "SHOT - OUT."
Rounds on the way.	25 - 655		35. PLATOON LEADER OBSERVES TARGET AREA (BINOCULARS).

Frame: 6

SCALE:
¼"=200m



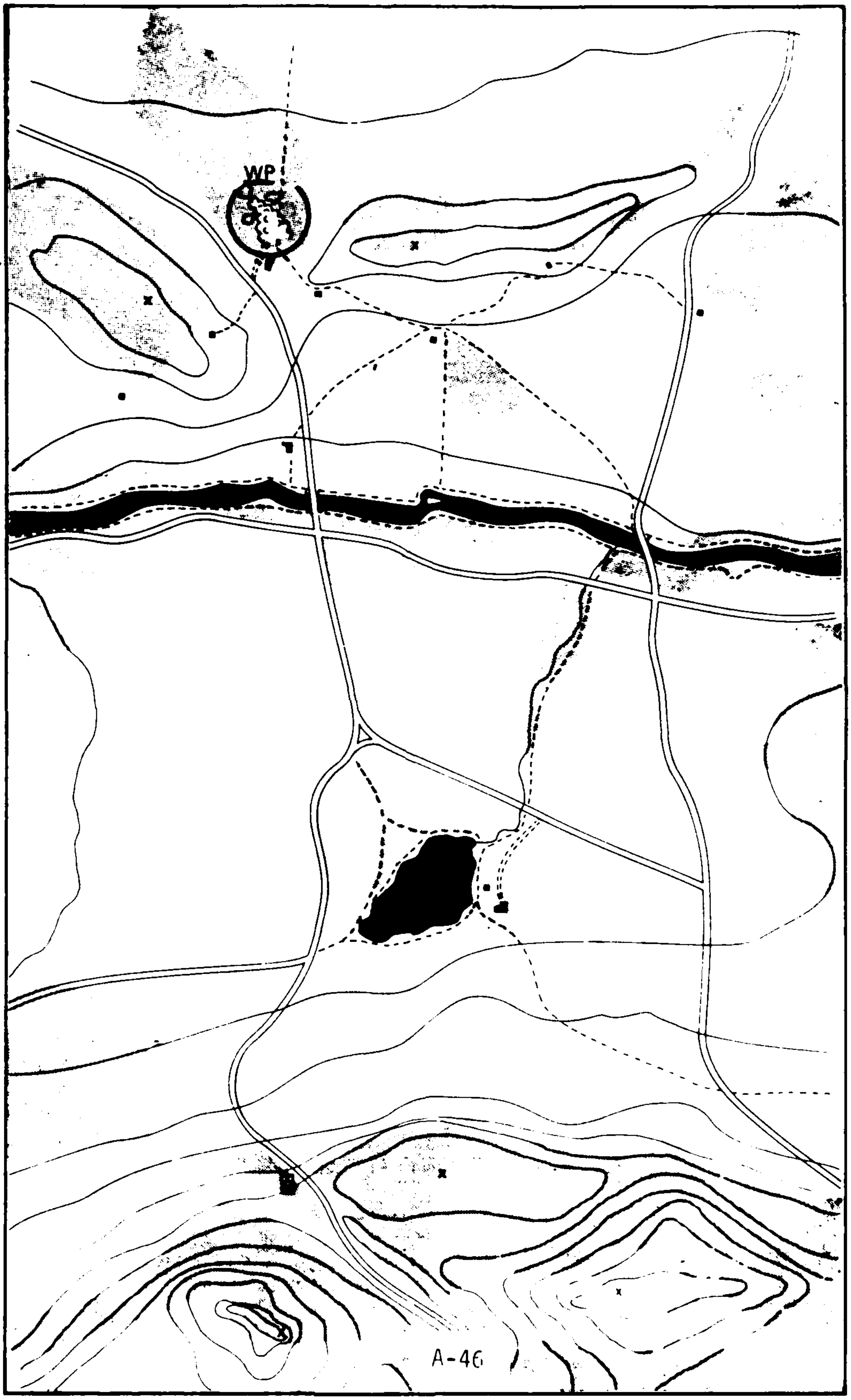
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 7**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	5 - 665	Shell impacts in the woods above AA4001.	36. "CHARLIE 42 - FIRE FOR EFFECT - OVER."

Frame: 7

SCALE: ¼"=200m



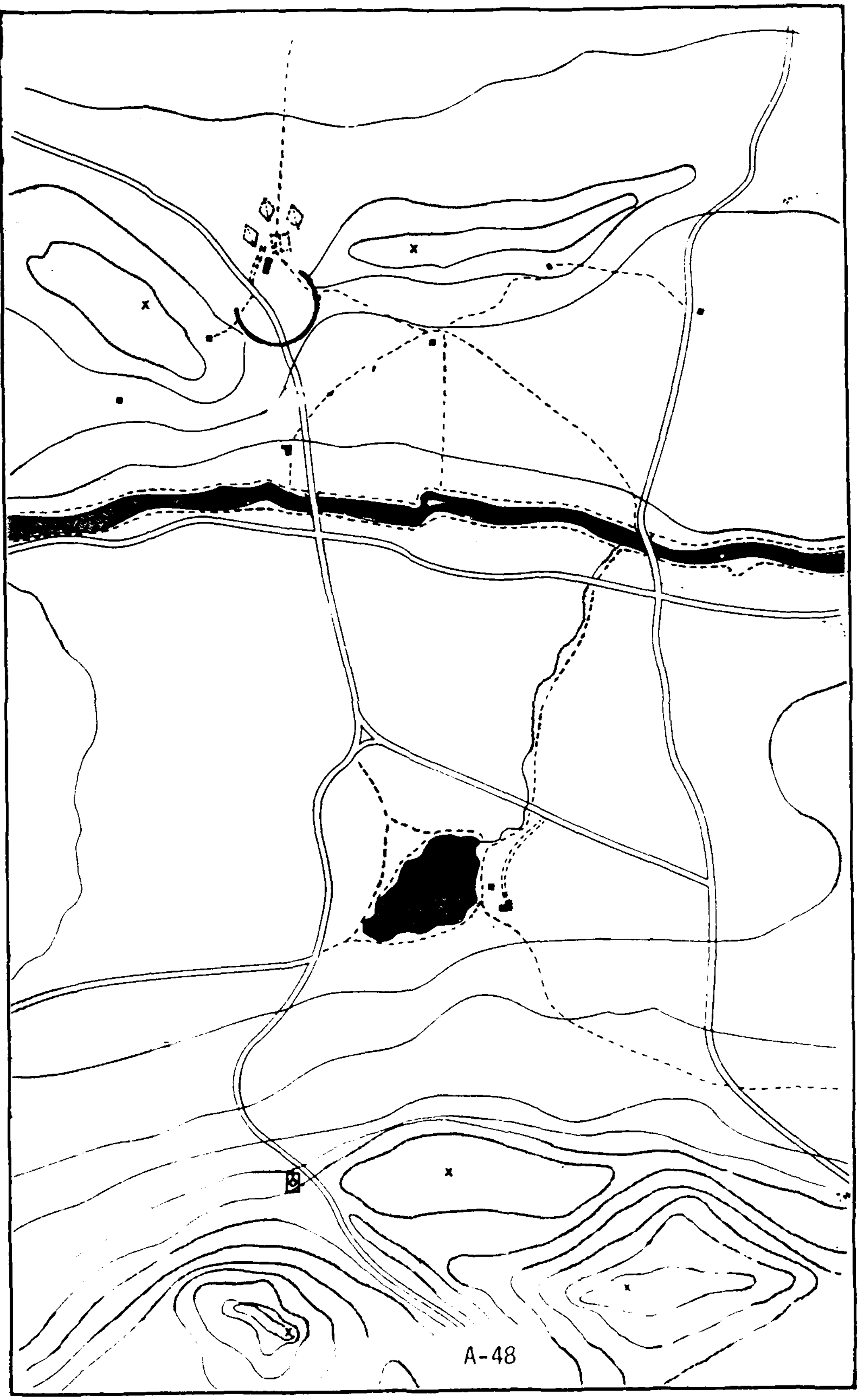
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 8**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
Mission working.	60-725		37. PLATOON LEADER OBSERVES TARGET AREA (BINOCULARS).
	5 - 730	38. "ROMEO 45 - SHOT - OVER."	
	5 - 735		39. "SHOT OUT."
Rounds on the way.	25 - 760		40. PLATOON LEADER OBSERVES TARGET AREA (BINOCULARS).

Frame: 8

SCALE:
¾=200m



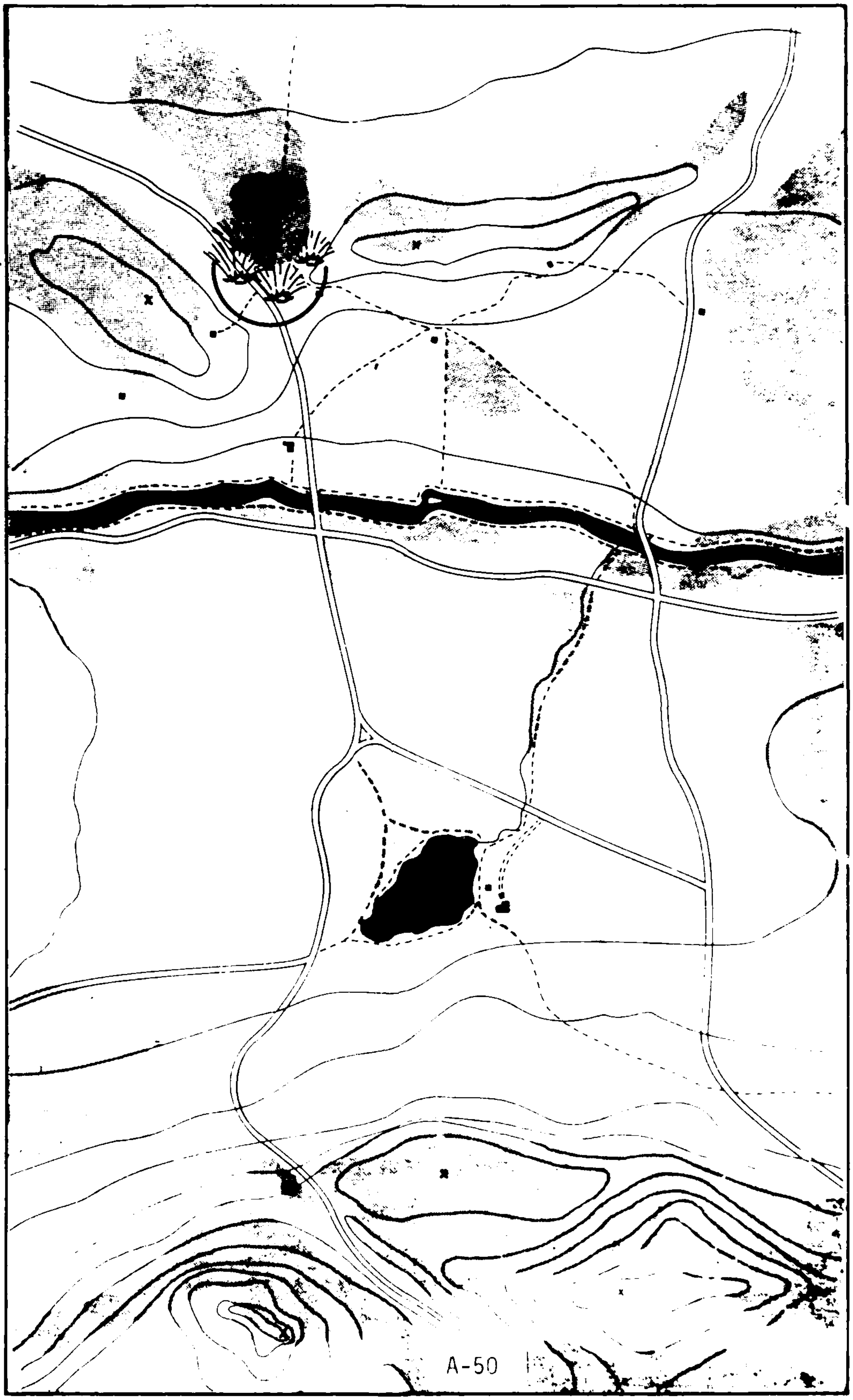
GO TO THE NEXT FRAME

Scenario 2 **Frame: 9**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		<u>DISPLAY</u>	
	10 - 770	Rounds impact near and in the woods. A secondary explosion is seen.	
	5 - 775		41. "CHARLIE 42 - REPEAT FIRE FOR EFFECT - OVER."
	5 - 780	42. "REPEAT FIRE FOR EFFECT - OUT."	

Frame: 9

SCALE:
¾"=200m



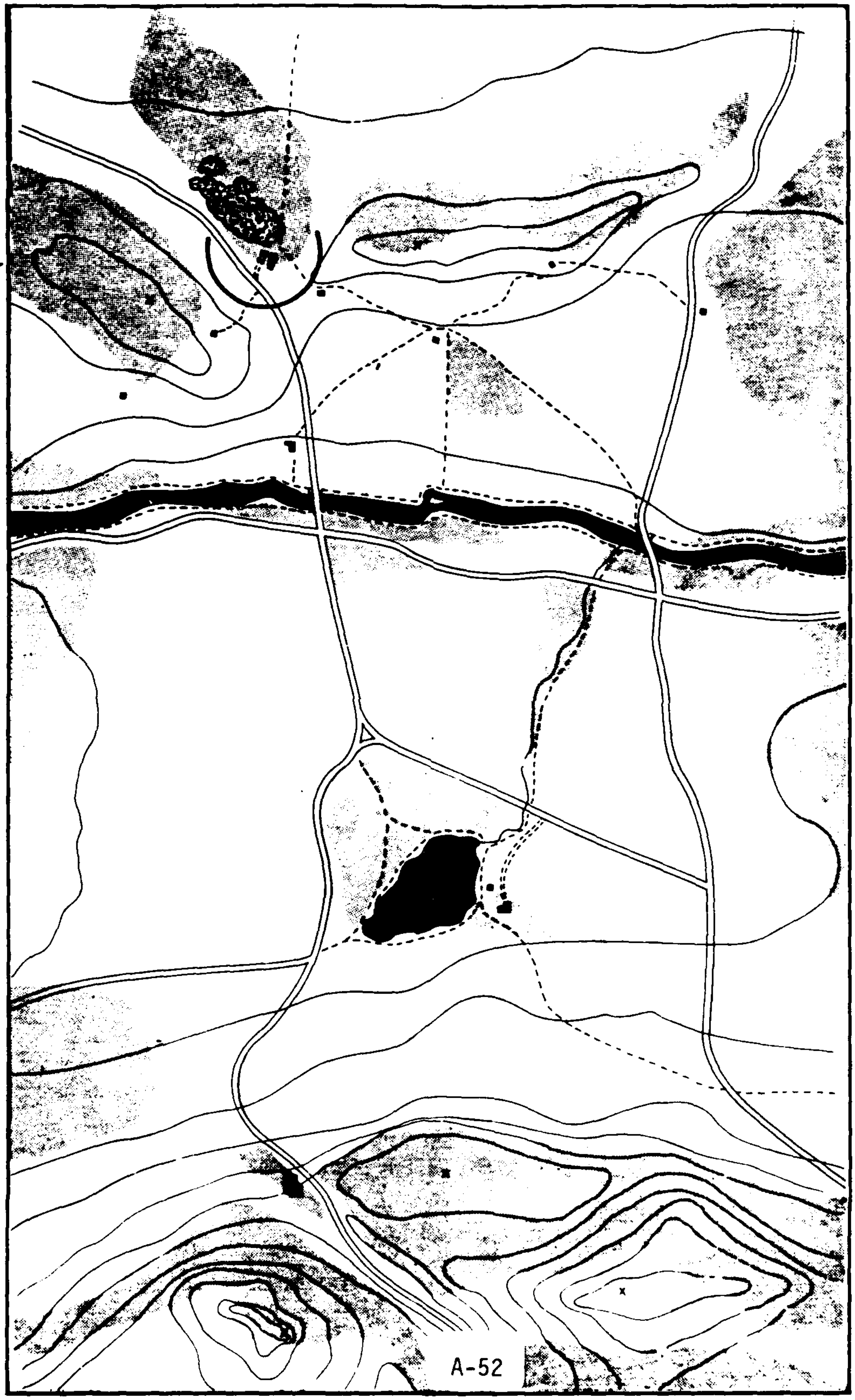
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 10

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
Mission working.	60 - 840	Billowing smoke from wooded area.	42. PLATOON LEADER OBSERVES TARGET AREA (BINOCULARS)
	5 - 845	43. "ROMEO 45 - SHOT - OVER."	
	5 - 350		44. "SHOT - OUT."
Rounds on the way.	20 - 370		45. PLATOON LEADER OBSERVES TARGET AREA.

Frame:10

SCALE:
¾=200m



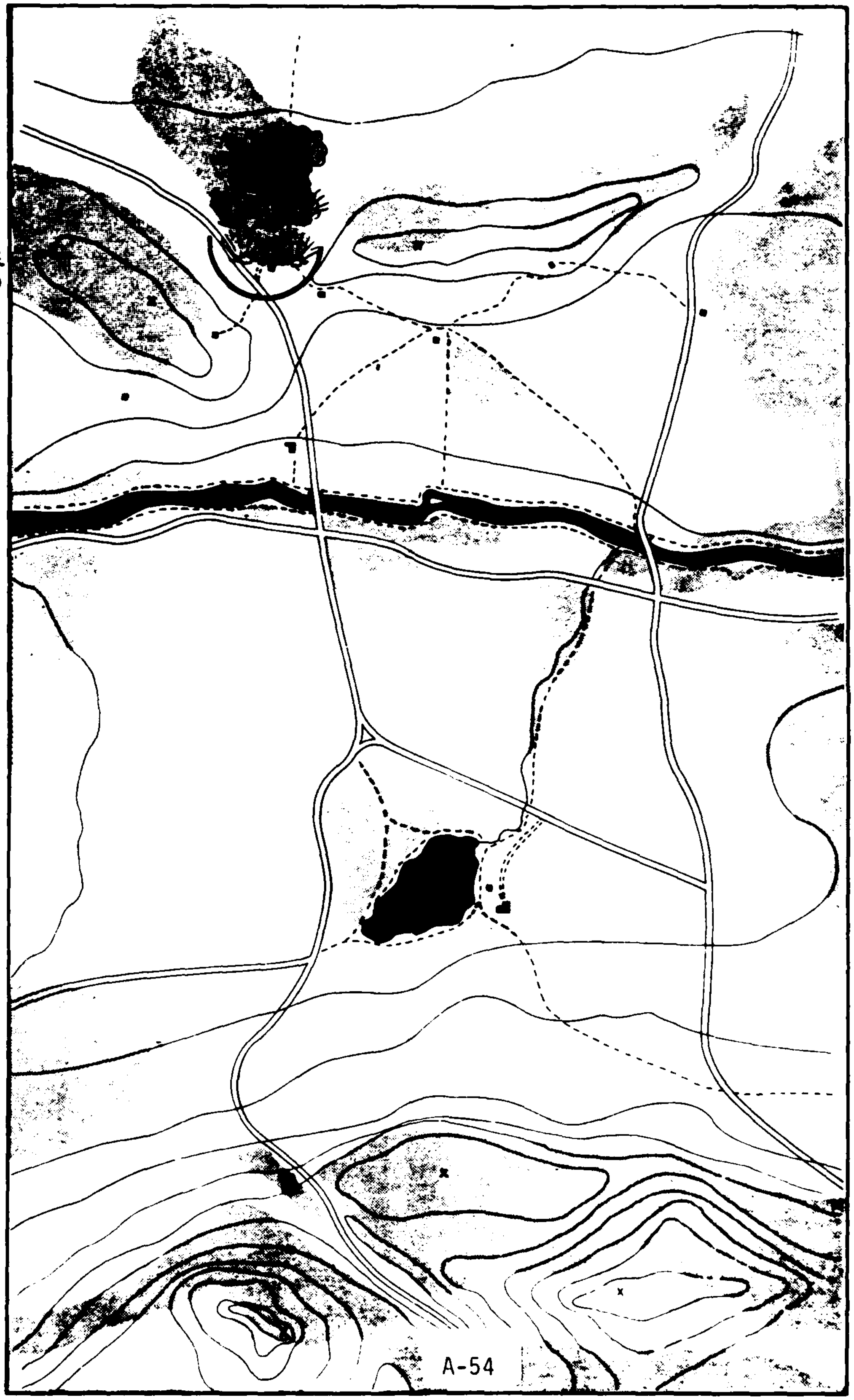
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 11

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	10 - 880	Rounds impact in and near the woods. Two secondary explosions are seen.	46. STUDENT OBSERVES IMPACTING ROUNDS.

Frame: 11

SCALE:
¾=200m



GO TO
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FRAME

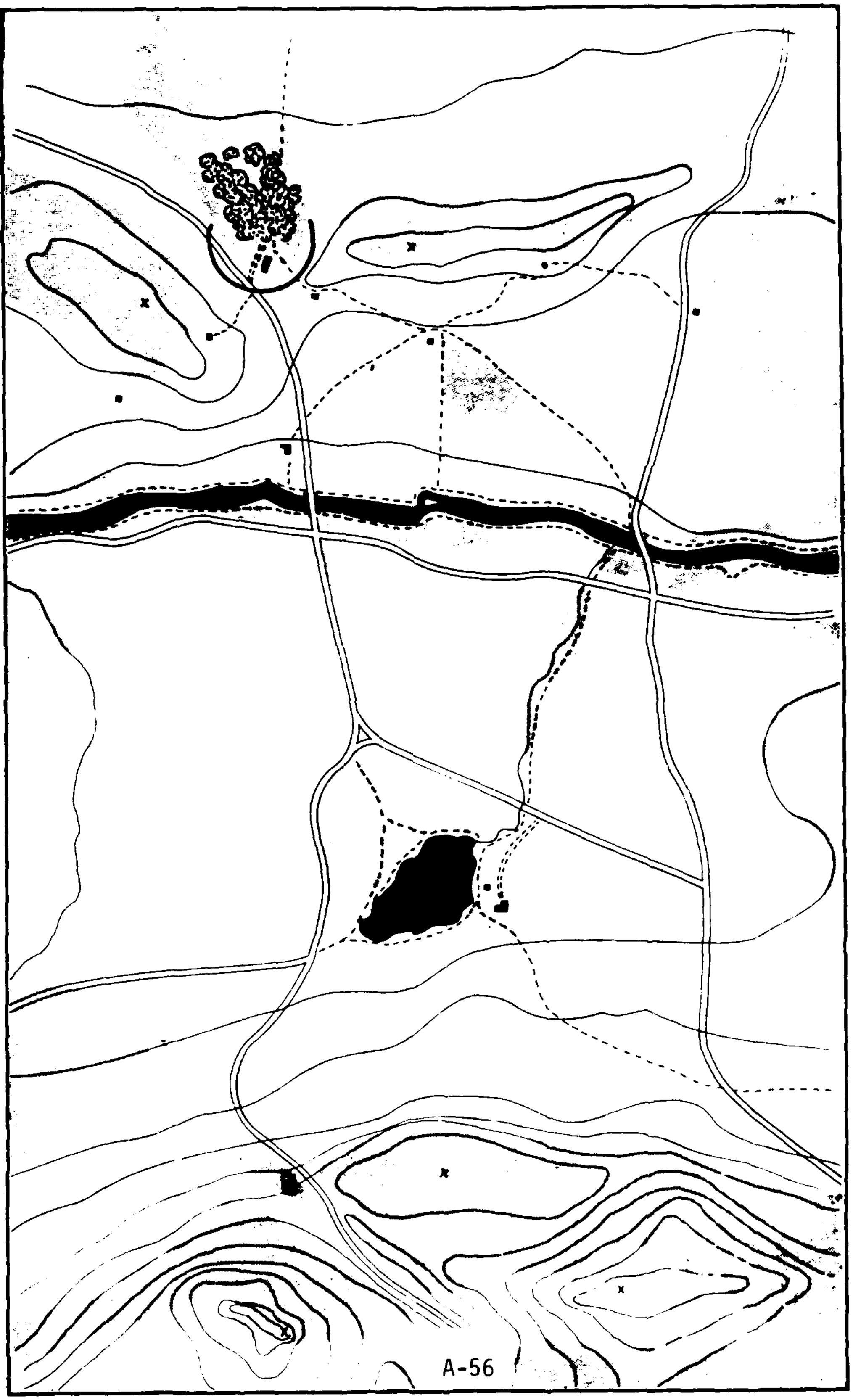
Scenario 2

Frame: 12

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	20 - 900	Billowing smoke from woodline.	47. "CHARLIE 42 - END OF MISSION - TWO SECONDARY EXPLOSIONS AND TWO FIRES. GOOD TARGET DAMAGE - OUT."
			ON COMPANY NET
	5 - 905	ON COMPANY NET	48. "YANKEE 51 - THIS IS ROMEO 45. SPOT REPORT - OVER."
	5 - 910	49. "THIS IS YANKEE 51 - OVER."	
	20 - 930		50. "THIS IS ROMEO 45 - CHARLIE 42'S FIRES IN WOODLINE EAST OF ALPHA ALPHA FOUR ZERO ZERO ONE PRODUCED TWO SECONDARY EXPLOSIONS AND TWO FIRES. ESTIMATE EXTENSIVE TARGET DAMAGE. HAVE GIVEN CHARLIE 42 END OF MISSION - OVER."
	5 - 935	51. "THIS IS YANKEE 51 - ROGER OUT."	

Frame:12

SCALE:
¾"=200m



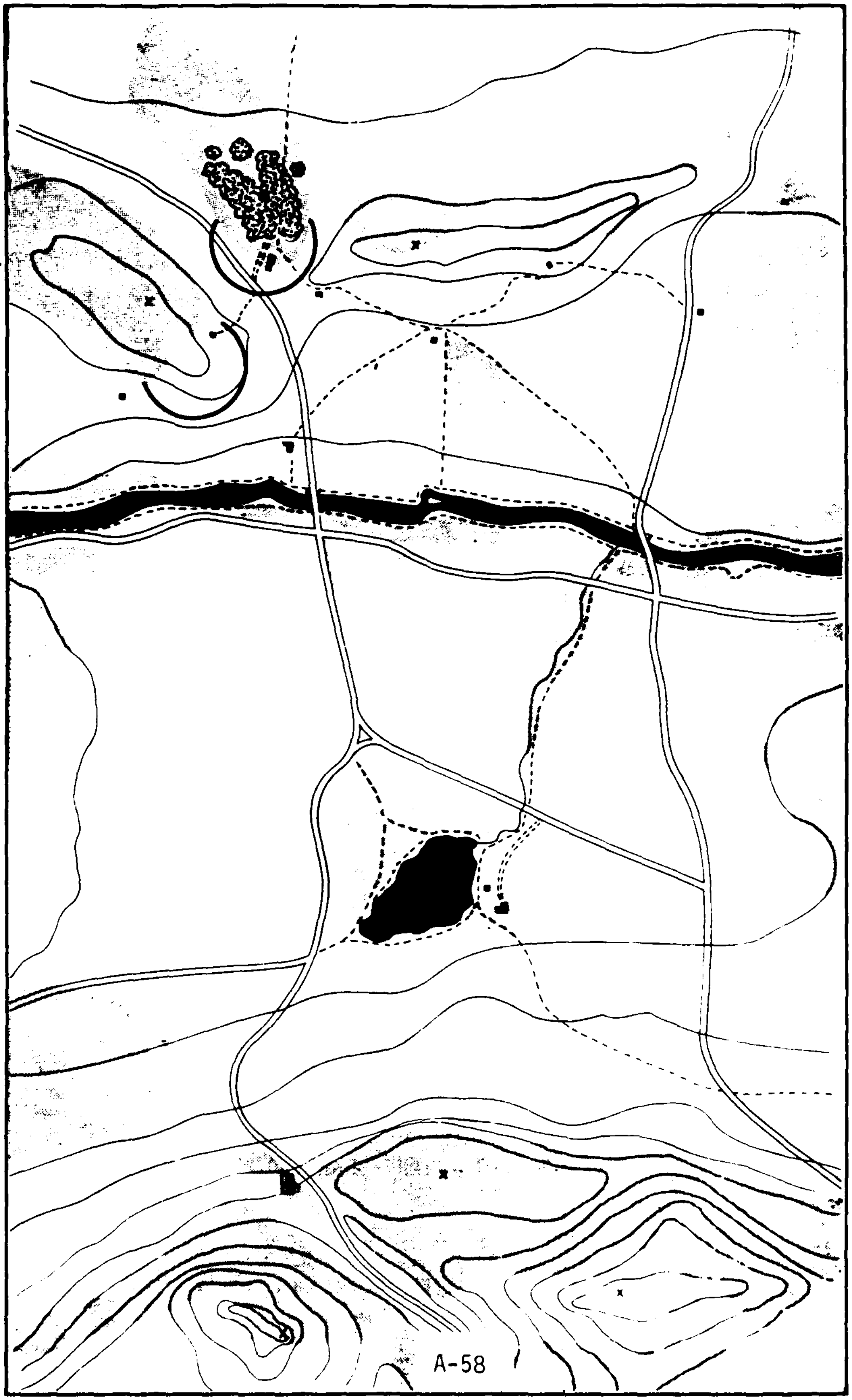
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 13

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	120-1055	No new activity. Smoke continues to rise out of target area.	52. PLATOON LEADER RESUMES SEARCH OF HIS SECTOR FOR ENEMY ACTIVITY (BINOCULARS).

Frame: 13

SCALE:
¾=200m



GO TO
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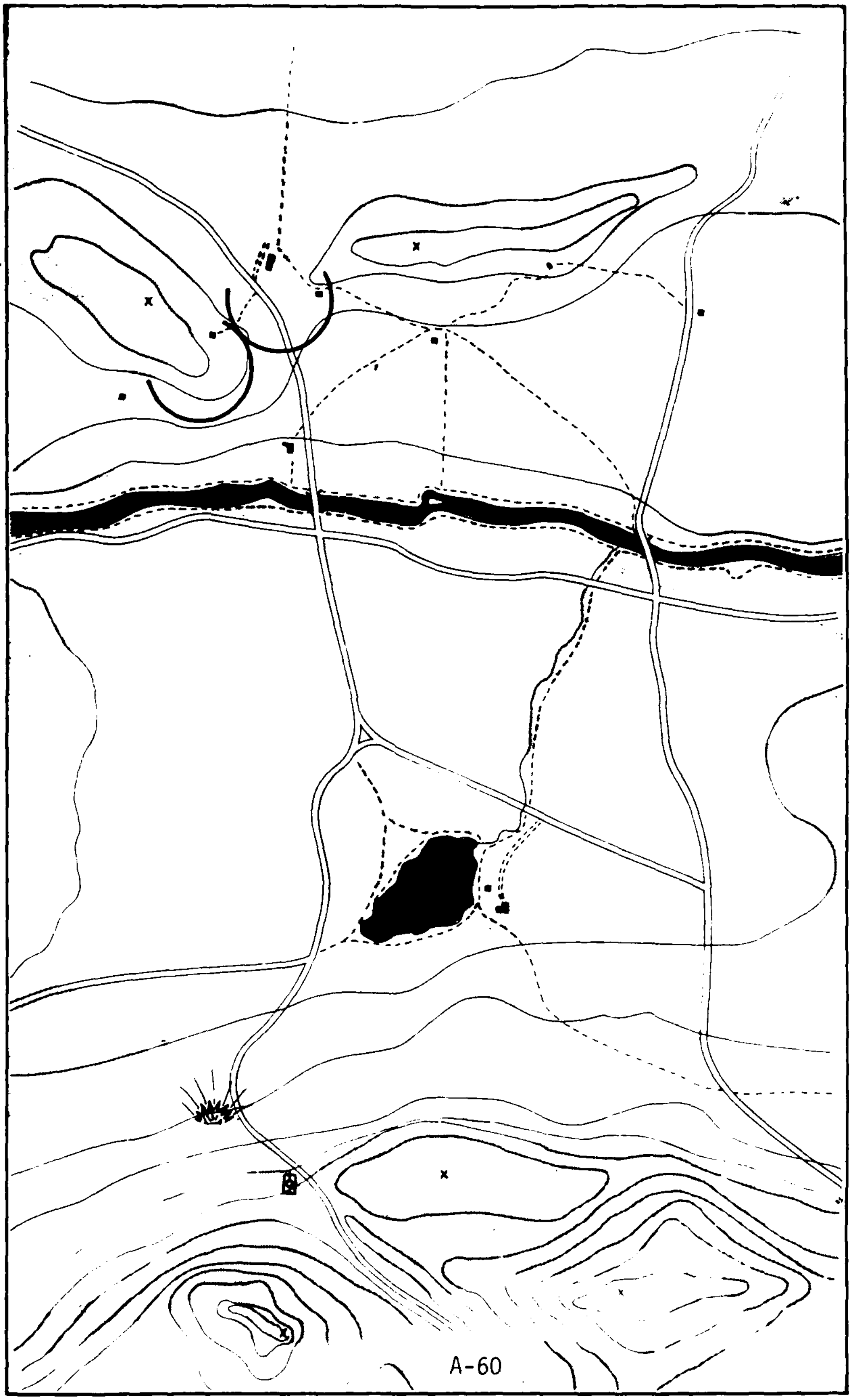
FRAME

Scenario 2 **Frame: 14**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	2-1075	Impacting artillery round.	
			ON PLATOON NET
	5-1062		53. "ROMEO - THIS IS ROMEO 45. INCOMING. BUTTON UP - OUT."

Frame: 14

SCALE:
¾=200m



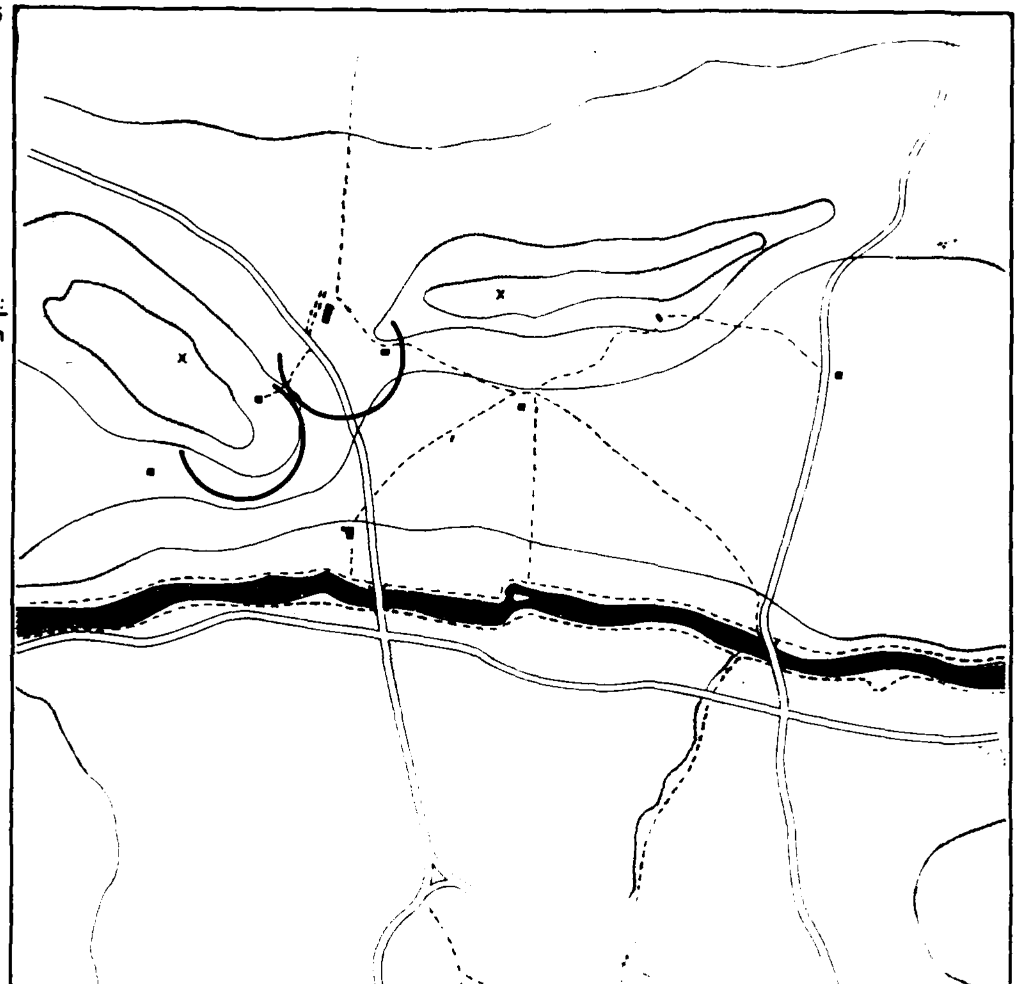
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 15**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	60-1122	No new activity.	54. PLATOON LEADER CONTINUES TO SEARCH AREA OF RESPONSIBILITY. (TANK COMMANDER'S (TC) SIGHT OR VISION BLOCKS)

Frame:15

SCALE:
¾"=200m



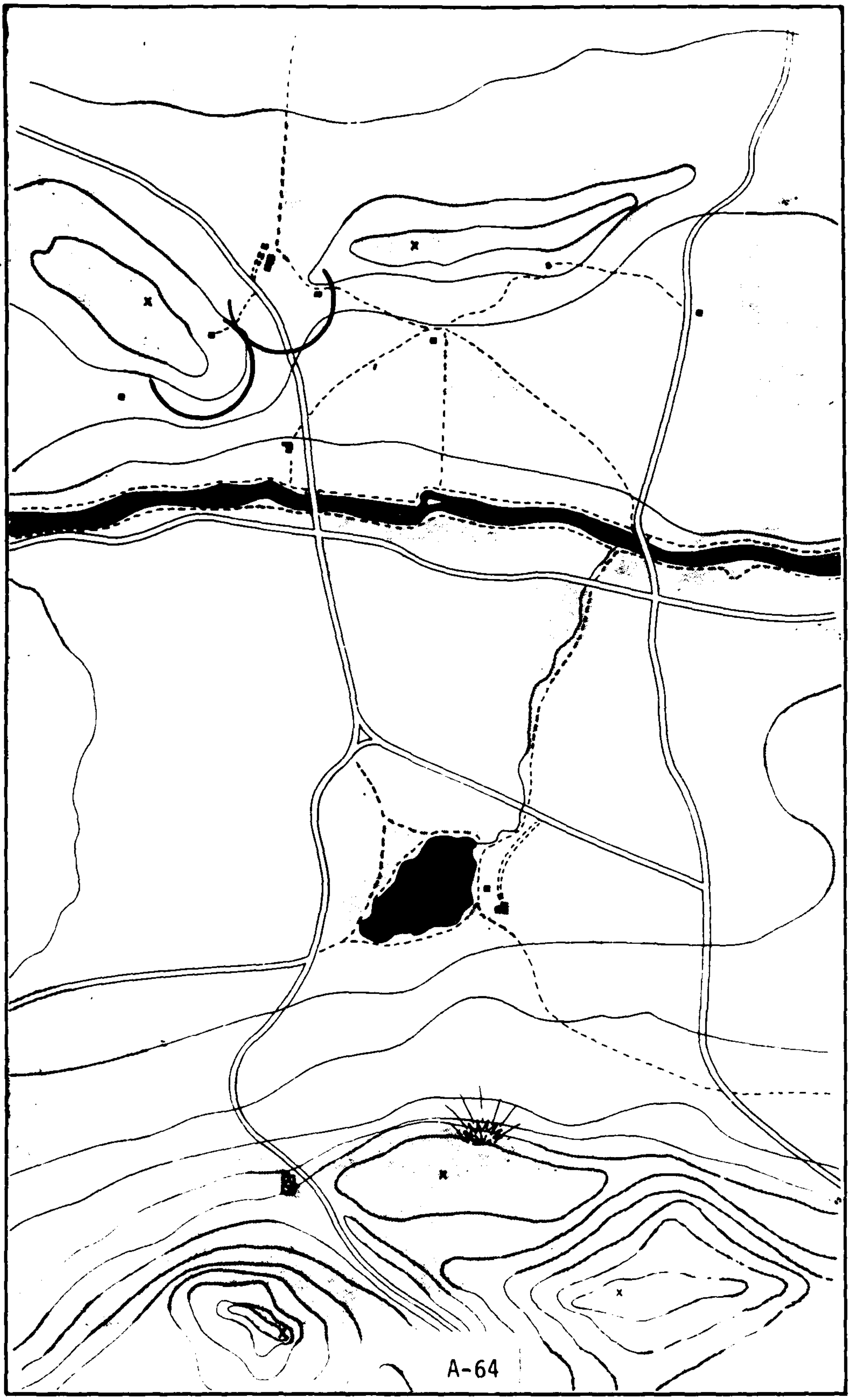
GO TO THE NEX FRAME

Scenario 2 **Frame: 16**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		NON VOICE AUDIO	
	3-1125	Sound of impacting artillery round towards center of platoon position.	
	5-1130	55. "ROMEO 45 - THIS IS ROMEO 36 - INCOMING ONE TWENTY TWO ROUND SEVENTY FIVE MIKES HOME PLATE - OUT."	ON COMPANY NET
	5-1135	ON COMPANY NET	56. "YANKEE 51 - THIS IS ROMEO 45. SPOTREP - OVER."
	5-1140	57. "THIS IS YANKEE 51 - OVER."	
	10-1150		58. "THIS IS ROMEO 45. ONE TWENTY TWO BEING ADJUSTED ROMEO SECTOR OVER."
	5-1155	59. "THIS IS YANKEE 51 - ROGER - OUT."	

Frame: 16

SCALE:
¼ = 200m



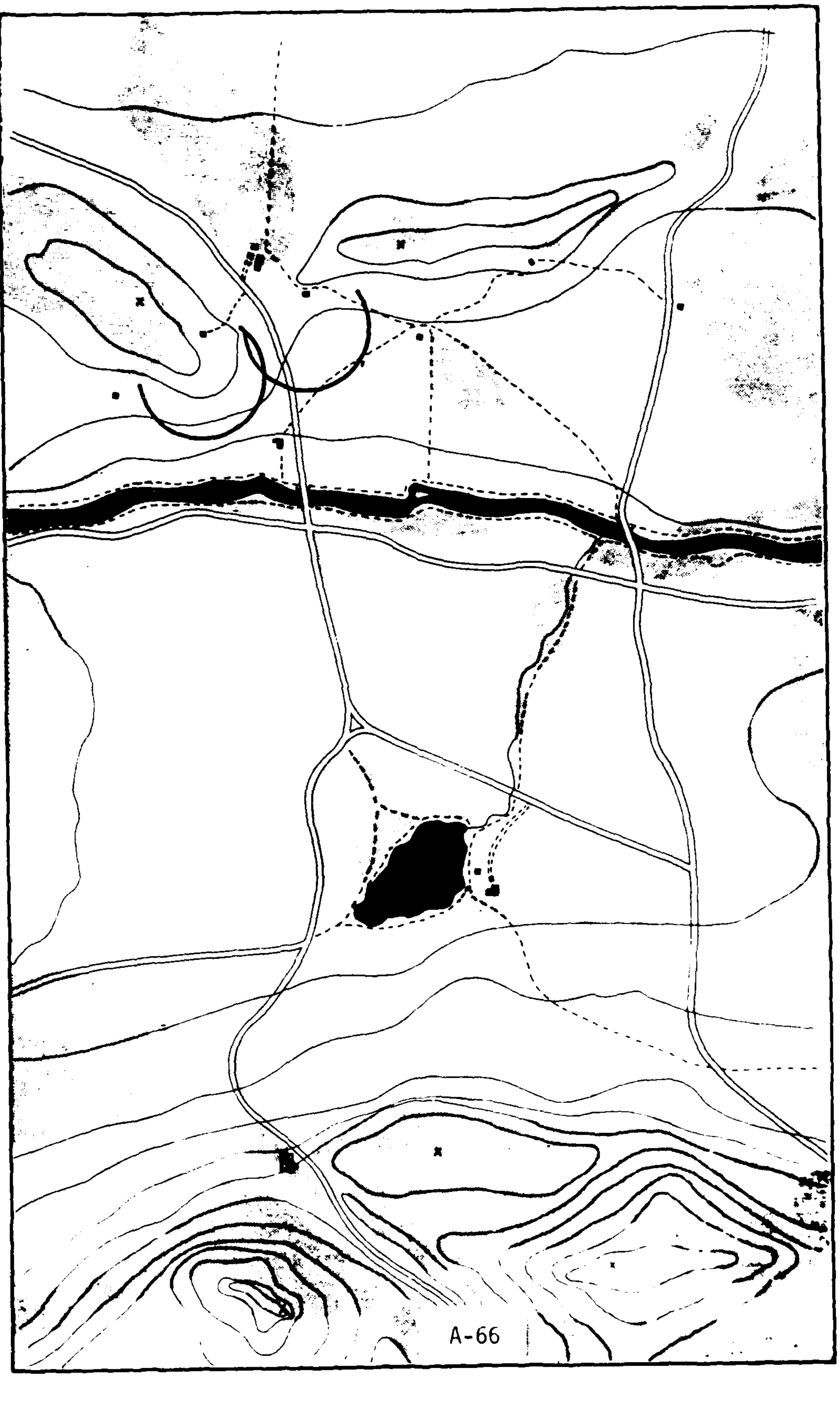
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 17**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		<u>DISPLAY</u>	
	120-1275	No new activity.	60. PLATOON LEADER CONTINUES TO SEARCH SECTOR (TC SIGHT OR VISION BLOCKS).

Frame: 17

SCALE:
¾=200m



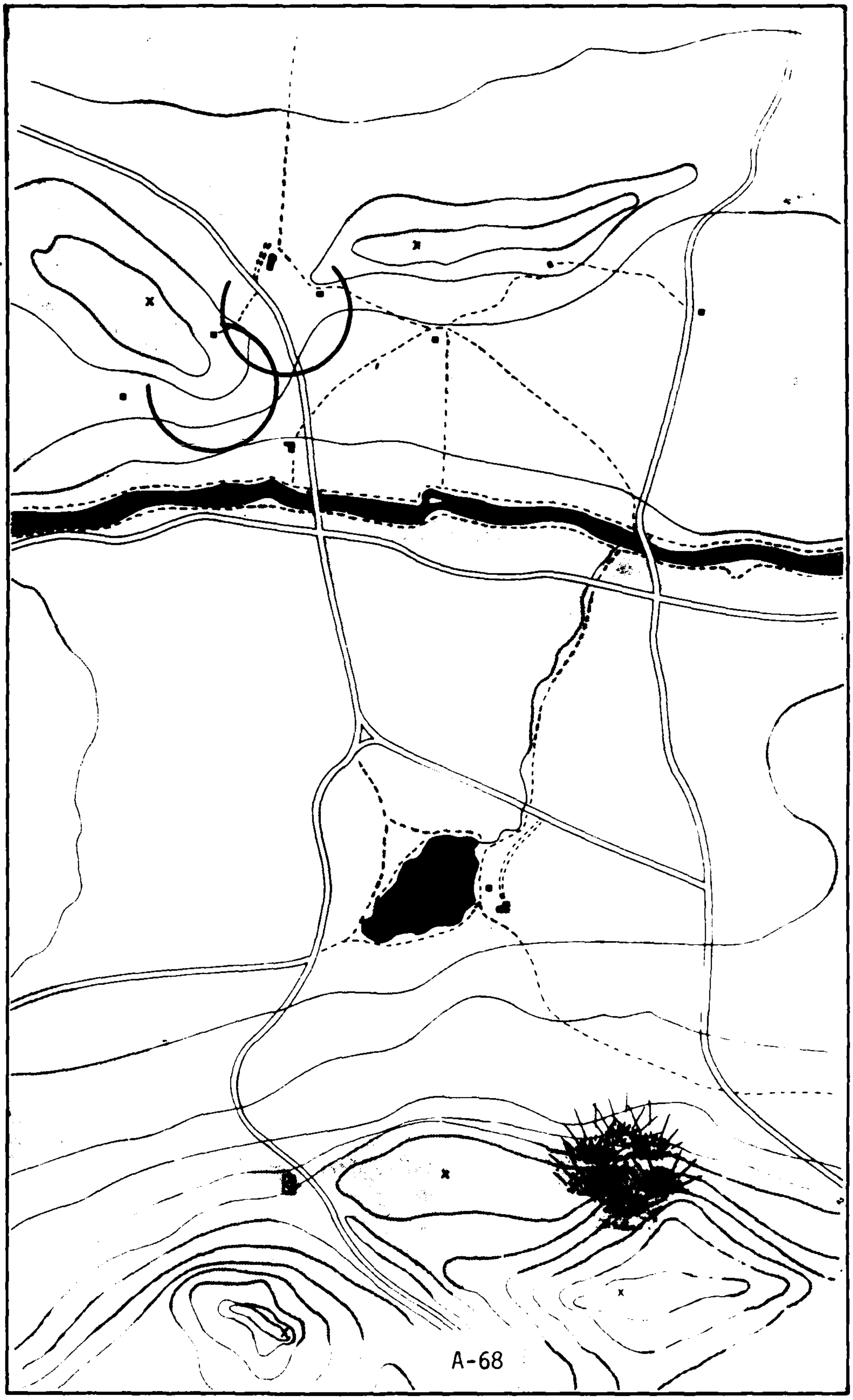
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 18**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
OPFOR artillery impacts on ROMEO BLUE's position.	60-1335	<u>NON VOICE AUDIO</u> Sound of impacting artillery in ROMEO BLUE's area (Right flank of platoon's defensive positions).	61. PLATOON LEADER CONTINUES TO SEARCH SECTOR.

Frame: 18

SCALE:
¾=200m



GO TO
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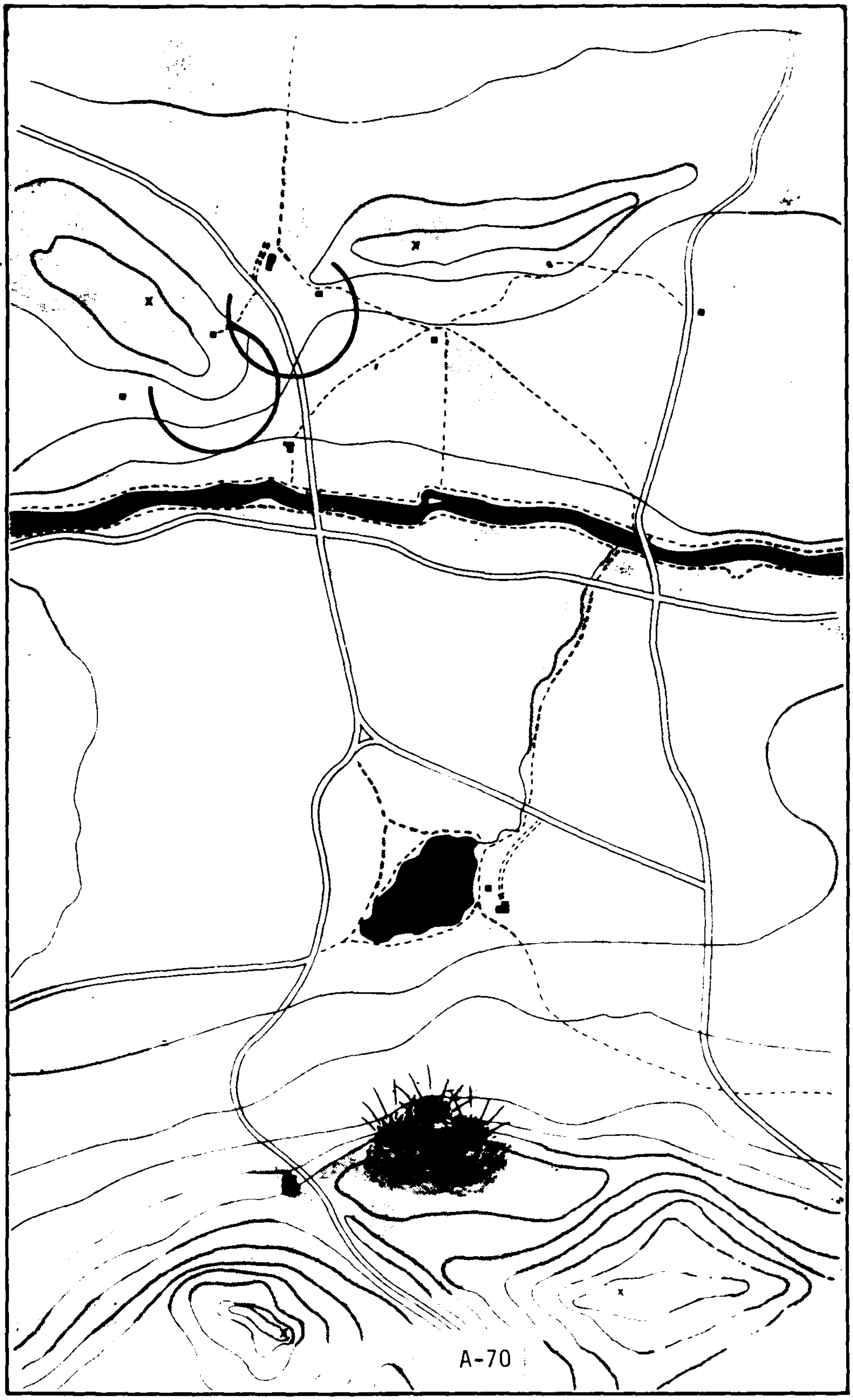
FRAME

Scenario 2 **Frame: 19**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
Twelve addition rounds of 122mm impact along platoon sector.	55-1390	NON VOICE AUDIO Sound of impacting artillery to right of Platoon Leader's position (center of platoon sector).	62. PLATOON LEADER CONTINUES TO SEARCH SECTOR.

Frame:19

SCALE:
¾"=200m



GO TO
THE NEXT
FRAME

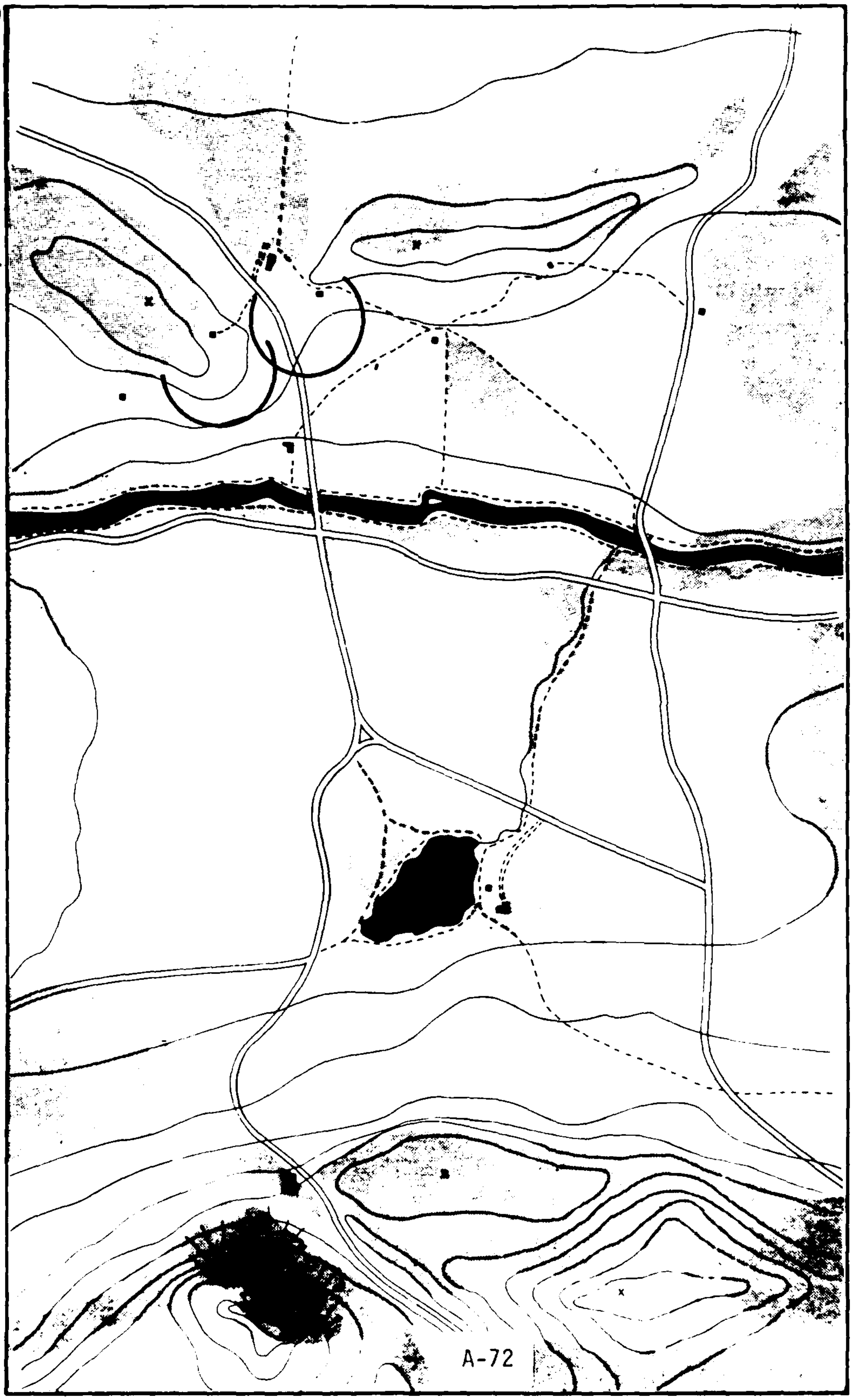
Scenario 2

Frame: 20

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON PLATOON NET
	5-1395		63. "ROMEO - THIS IS 45. REPORT - OVER."
		ON PLATOON NET	
	15-1410	64. "THIS IS 27 - ROGER - OUT." "36 - ROGER - OUT" "64 - ROGER - OUT"	
			65. "ROMEO - THIS IS 45. MONITOR SECTORS. EXPECT ATTACK - OUT."
OPFOR artillery - fire is shifted to rear of platoon's position.	1420-1490	NON VOICE AUDIO Sound of impacting artillery to rear of Platoon's position.	
			ON COMPANY NET
	5-1420		66. "YANKEE 51 - THIS IS ROMEO 45. STAREP - OVER."
		ON COMPANY NET	
	5-1425	67. "THIS IS YANKEE 51 - OVER."	
	20-1445		68. "THIS IS ROMEO 45. TIME ___. LINE CHARLIE - APPROXIMATELY THIRTY ROUNDS ONE TWENTY TWO MIKE MIKE SALLY. FIRE HAS BEEN SHIFTED TWO HUNDRED MIKES WEST OF SALLY. ALL OTHER LINES NO CHANGE - OVER."

Frame: 20

SCALE:
¾=200m



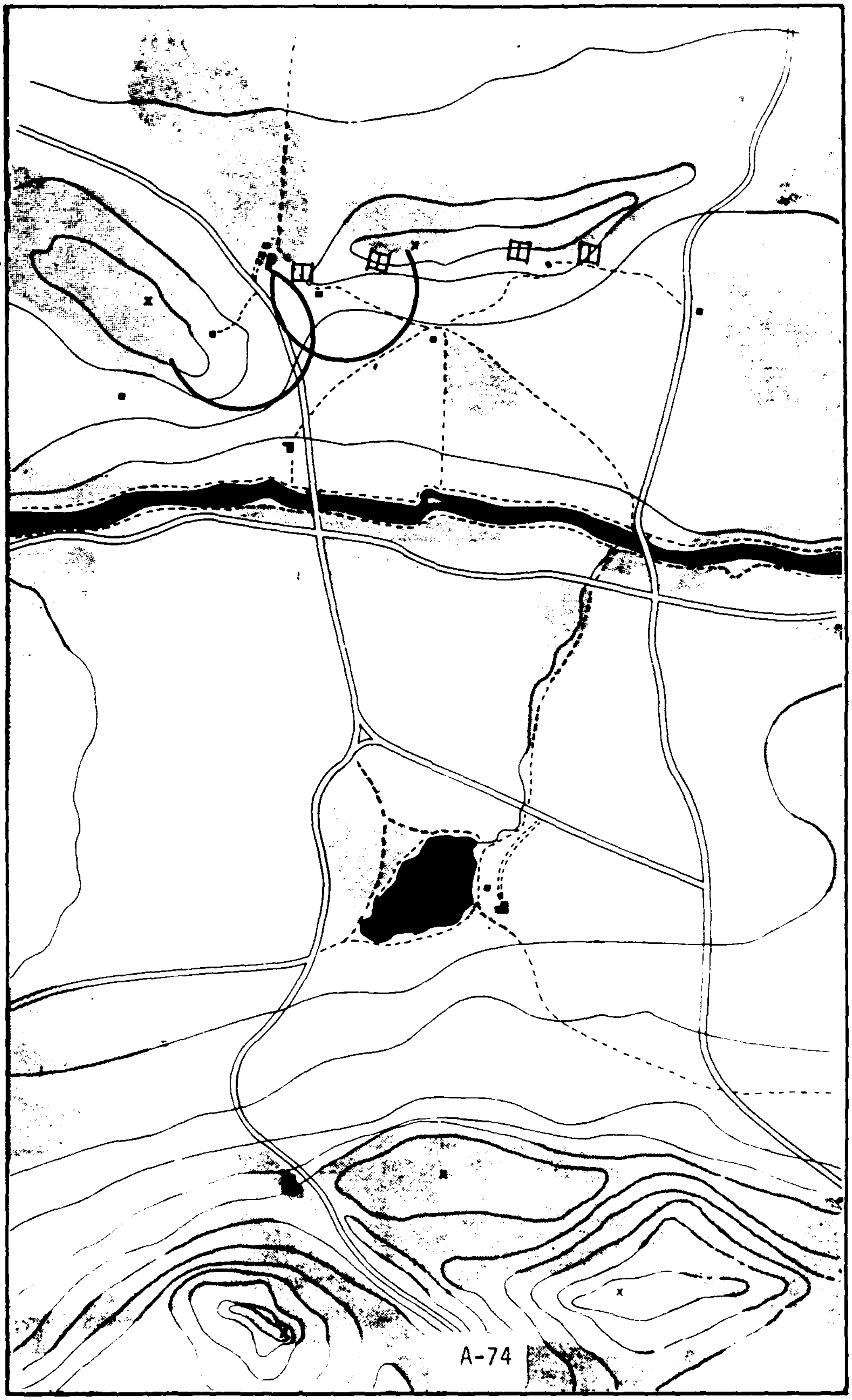
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 21**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	5-1450	69. "THIS IS YANKEE 51 - ROGER - OUT." DISPLAY	
	5-1455	Platoon leader observes: • Two T-80s moving west vicinity TRP 011. ON PLATOON NET	70. PLATOON LEADER RESUMES SEARCH OF SECTOR (BINOCULARS).
Simultaneous sighting made at 1455 seconds.	10-1460	71. "ROMEO 45 - THIS IS ROMEO 36. TWO TANGO EIGHTIES. VICINITY ZERO ONE ONE. MOVING WEST OVER."	72. PLATOON LEADER LOCATES TARGETS IN ROMEO 36'S SECTOR. ON PLATOON NET
	30-1490		73. "ROGER. BREAK - BRAVO 4 ROMEO - THIS IS ROMEO 45. SABOT. FOUR TANKS DIRECT FRONT. TWO THOUSAND. CROSS FIRE. DIRECTS TARGET ENGAGEMENT 74. PLATOON LEADER SLEWS TURRET TO RIGHT FLANK TANK.

Frame: 21

SCALE:
¾"=200m



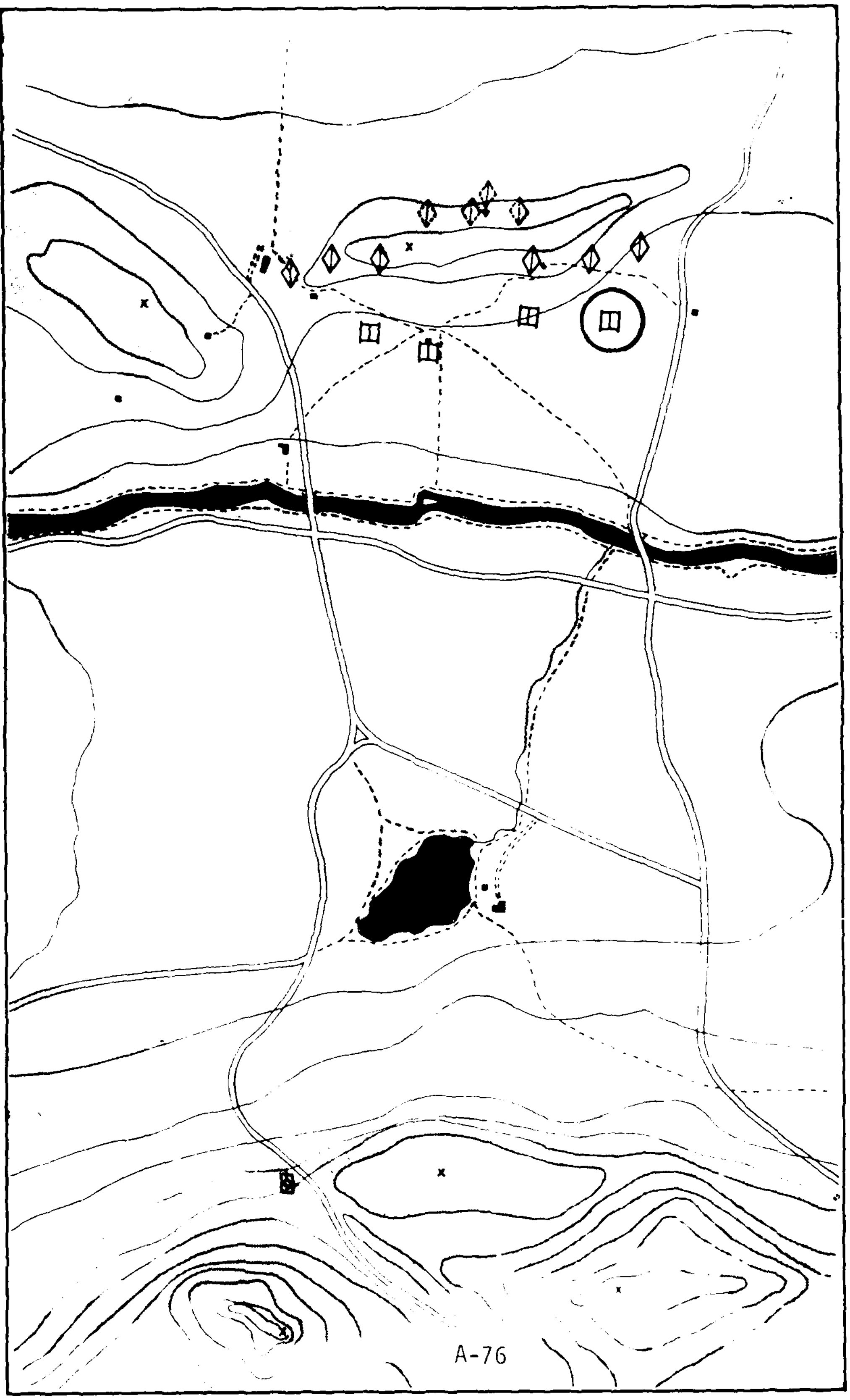
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 22**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON INTERCOM
	5-1495		74. "GUNNER - SABOT. RIGHT TANK."
		ON INTERCOM	
	5- 1500	75. LOADER -"UP" GUNNER - "IDENTIFIED"	
	2-1502	NON VOICE AUDIO	75. "FIRE".
		Sound of firing tank.	

Frame: 22

SCALE:
¾=200m



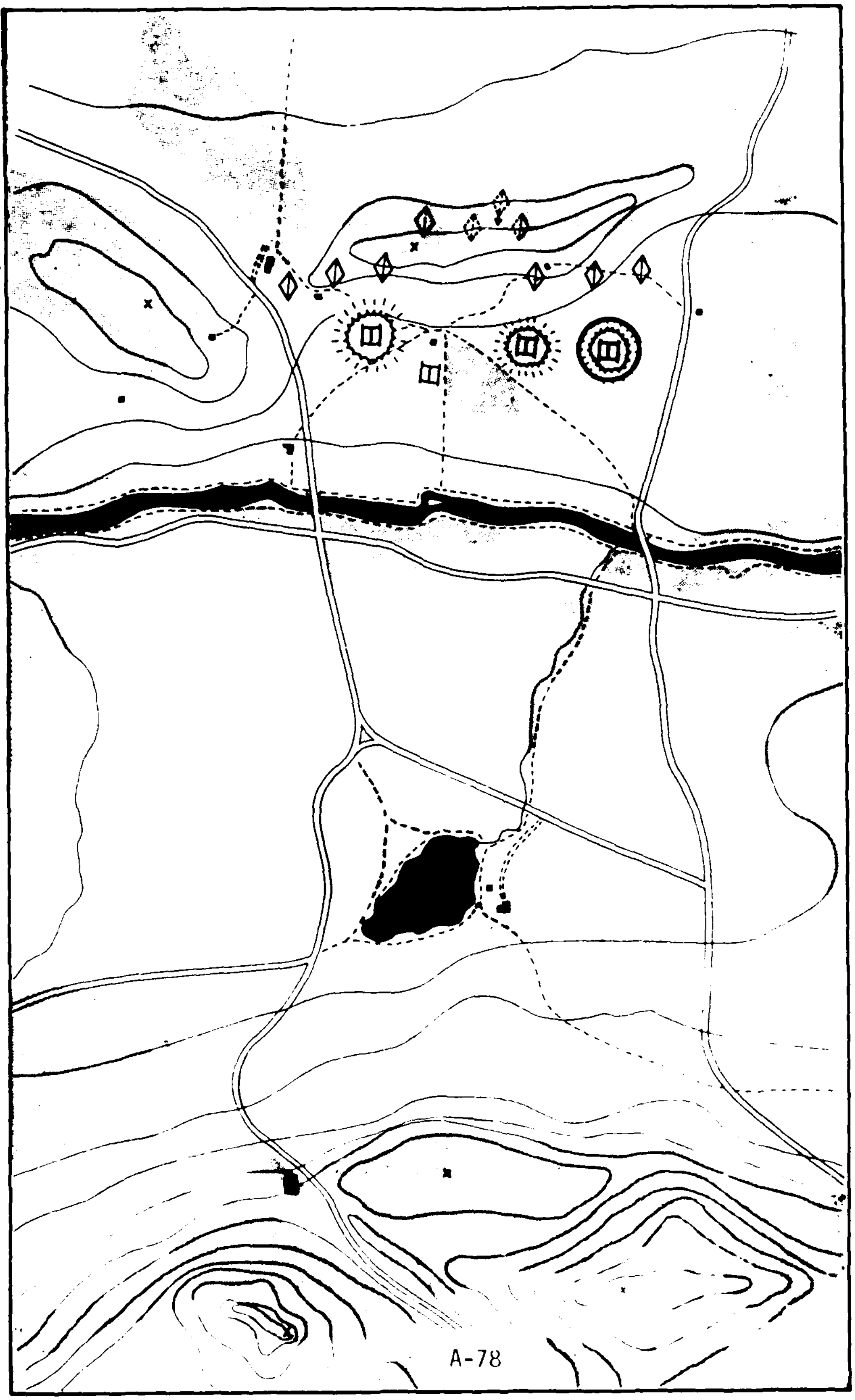
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 23

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	3-1505	Platoon leader observes: • His tank achieves a first round hit.	76. PLATOON LEADER HAS TARGET IN TC SIGHT.
ROMEO BLUE obtains a first-round hit on one T-80.	1506		

Frame: 23

SCALE:
¼"=200m



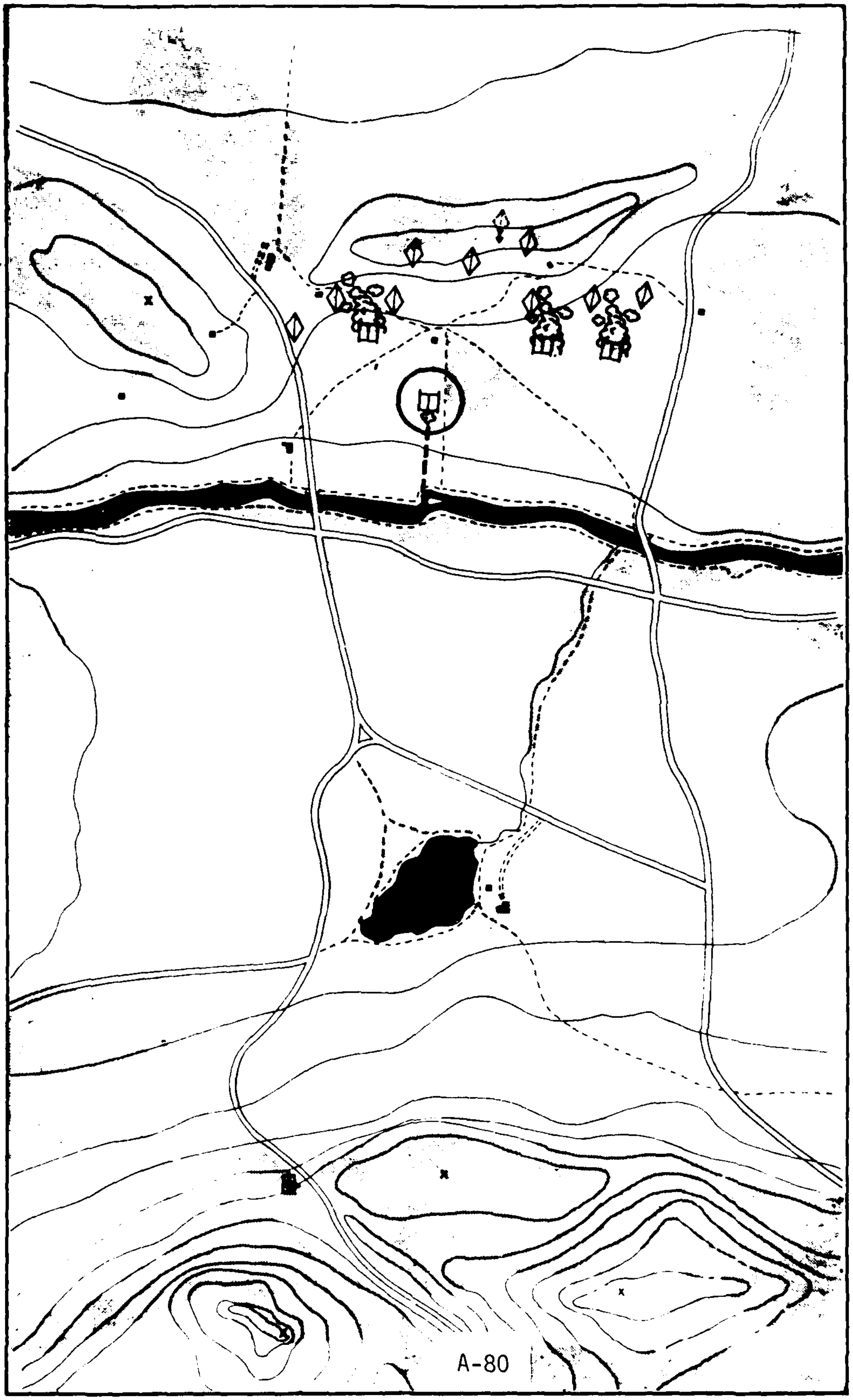
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 24**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		<u>DISPLAY</u>	
	3-1508	Platoon leader observes: • one of Romeo BLUE's targets returning fire.	77. PLATOON LEADER SLEWS TURRET TO 27'S TARGET.
			<u>ON INTERCOM</u>
	3-1511	<u>ON INTERCOM</u>	78. "GUNNER - SABOT TANK."
	3-1514	79. LOADER - "UP". GUNNER - "IDENTIFIED"	
	2-1516	<u>NON VOICE AUDIO</u>	80. "FIRE".
		Sound of firing tank.	

Frame: 24

SCALE:
¾=200m



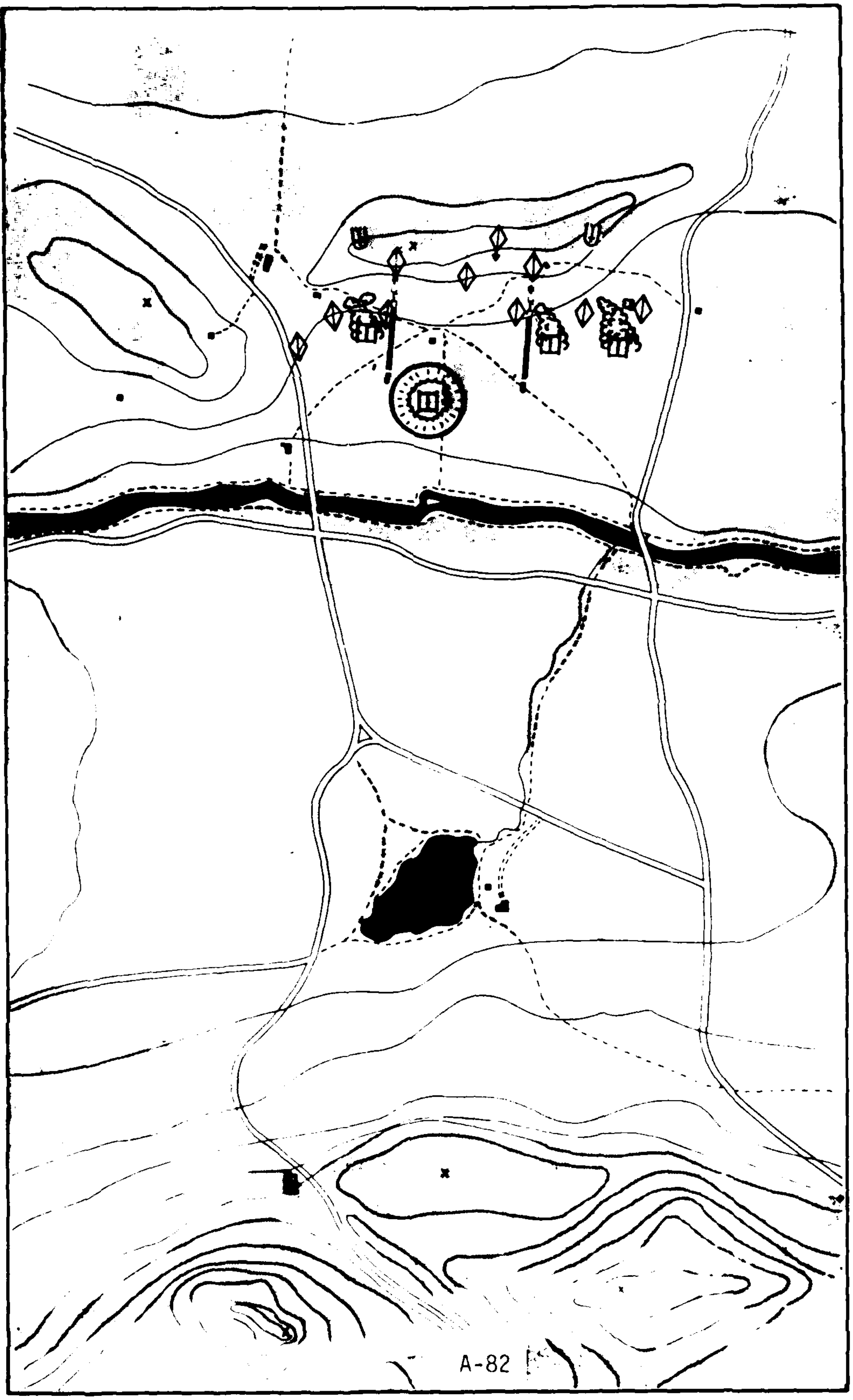
GO TO
THE NEXT
FRAME

Scenario 2 — Frame: 25

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		<u>DISPLAY</u>	
	3-1519	Platoon leader observes: ● His tank achieves a first round hit.	81. PLATOON LEADER HAS TANK IN TC SIGHT.
ATGM launch at 1520.	1520		

Frame: 25

SCALE:
⅞=200m



GO TO
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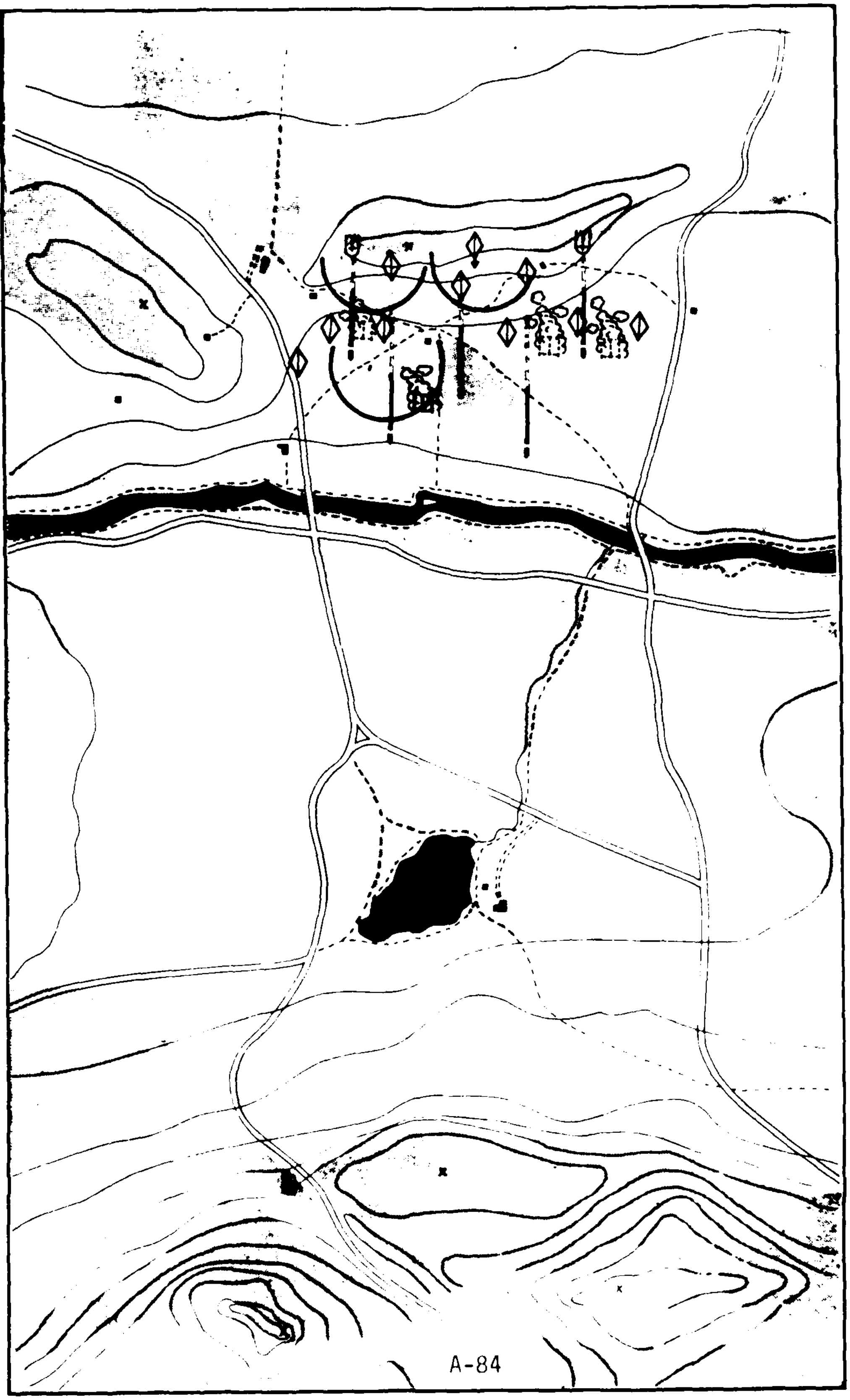
FRAME

Scenario 2 **Frame: 26**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	3-1522	Platoon leader observes: ● Three BMPs launching ATGM's ROMEO'S direction. One ATGM launched from Hill 202.	82. PLATOON LEADER SEARCHES FOR OTHER TARGET.
			ON PLATOON NET
	3-1525		83. "ROMEO - THIS IS 45. TALLY HO - OUT."
			ON INTERCOM
	3-1528		84. "DRIVER - BACK UP MOVE TO RIGHT ALTERNATE POSITION."

Frame: 26

SCALE:
¾"=200m



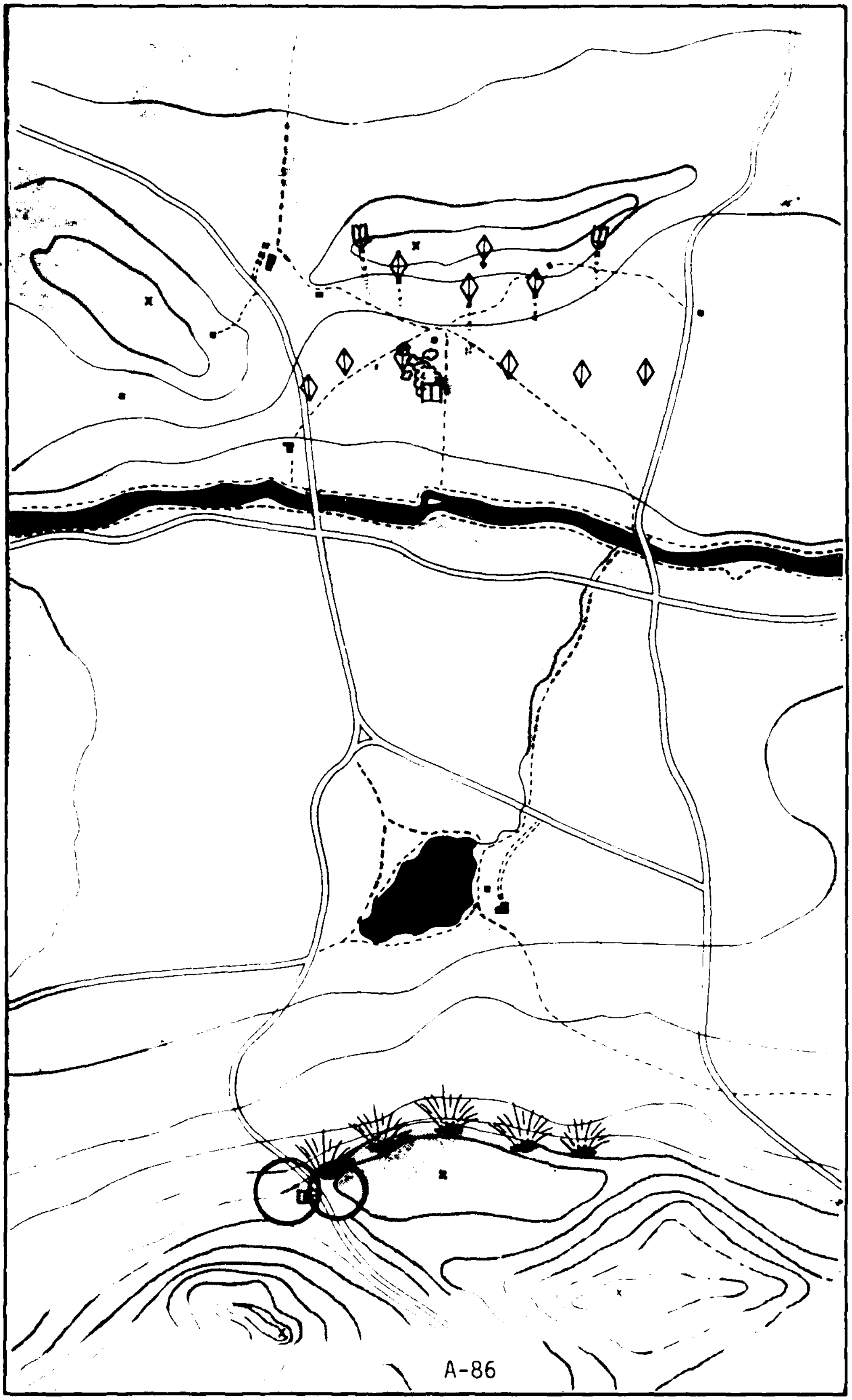
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 27

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		NON VOICE AUDIO	
Platoon leader's tank moving back to primary position.	1531 - 1535	Sound of exploding ATGM in vicinity of previous position.	
		ON PLATOON NET	
	5-1533	85. "ROMEO 45 - THIS IS 36. BLUE'S TARGETS DESTROYED. FIVE BRAVO MIKE PAPAS VICINITY TARGET BRAVO - OUT."	
			ON COMPANY NET
	5-1538		86. YANKEE 51 - THIS IS ROMEO 45. STAREP - OVER."
		ON COMPANY NET	
	3 - 1541	87. "THIS IS YANKEE 51 - OVER."	

Frame: 27

SCALE:
¼"=200m



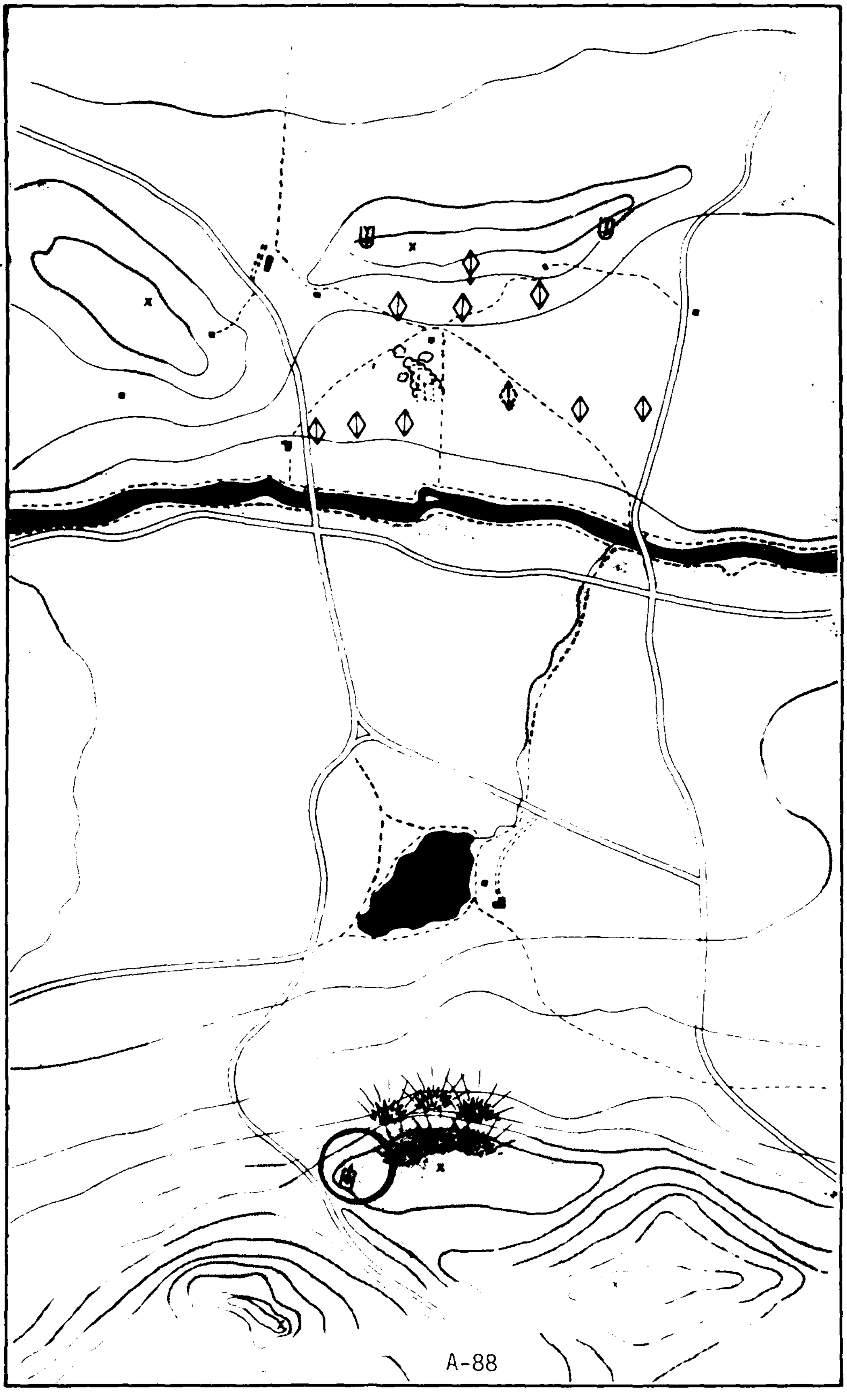
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 28

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		NON VOICE AUDIO	ON COMPANY NET
	39-1580	Sound of impacting 122mm (12 rounds) is heard towards center of platoon position.	88. "THIS IS ROMEO 45 - TIME NOW ___. LINE CHARLIE - FOUR TANGO EIGHTIES DESTROYED. TEN BRAVO MIKE PAPAS BETWEEN ALPHA FOUR ZERO ZERO TWO AND ALPHA FOUR ZERO ZERO ONE. SEVERAL ALPHA TANGO GOLF MIKES LAUNCHED. ROMEO TALLYHO. WILL REPORT BINGO REQUEST GOLF 17 AND MIKE 29 ENGAGE TARGETS WITH FLANK TANKS. LINE HOTEL REQUEST SUPPORT FROM CHARLIE 5 PAPA 23. REQUEST HE CALL ME MY PUSH FOR TARGET DESIGNATION. ALL OTHER LINES NO CHANGE - OVER."
	5-1585	89. "THIS IS YANKEE 51 - WILCO - OUT."	

Frame: 28

SCALE:
¾"=200m



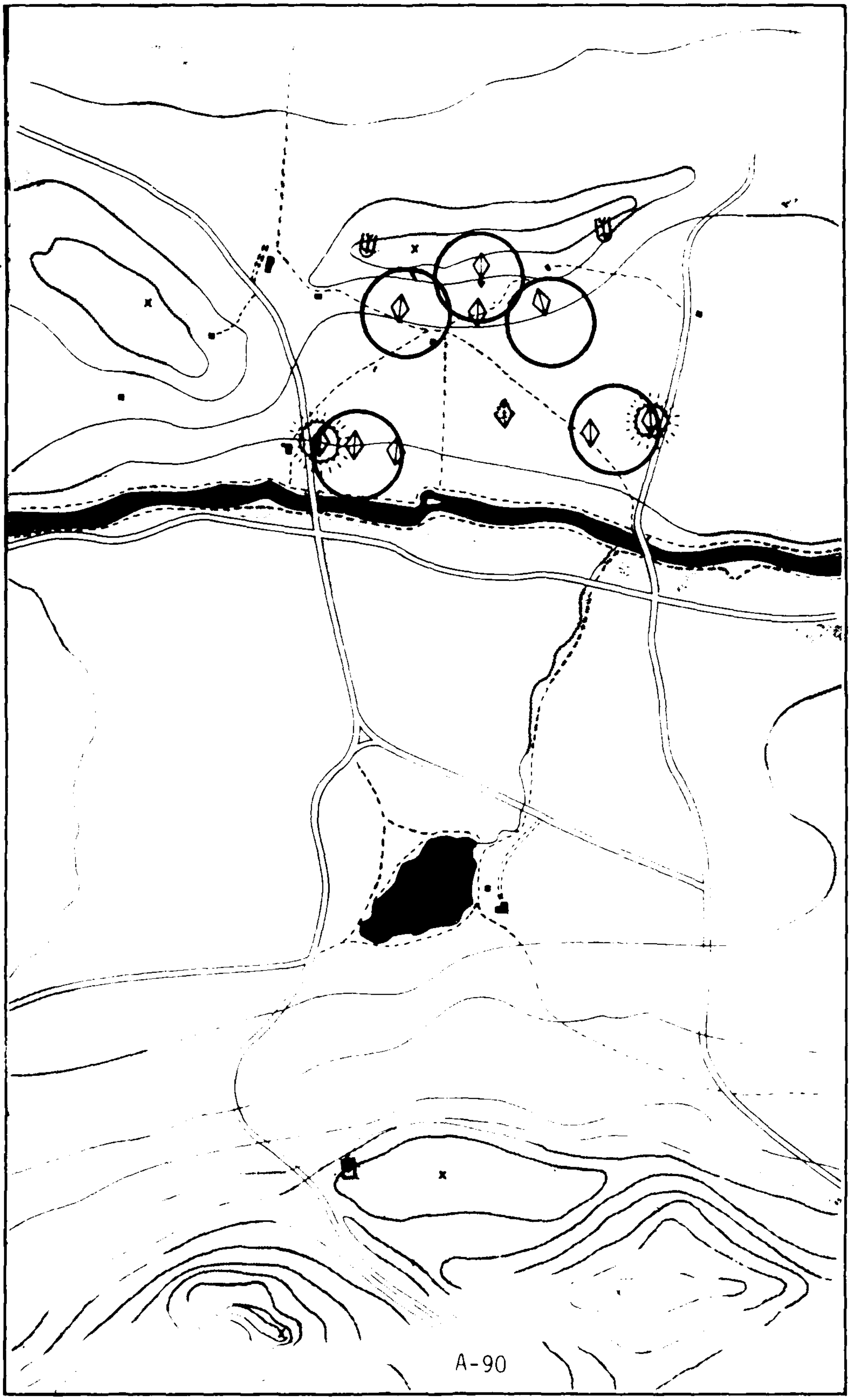
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 29**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
Platoon leader's tank arrives at new firing position. Third platoon's right flank tank destroys one BMP. Second platoon's flank tank also knocks out a BMP. Both tanks receive ATGM fire.	5-1610	DISPLAY Platoon leader observes: • Three BMPs left of target BRAVO and five BMPs right of target BRAVO. • ATGM Launch against 2nd and 3rd Platoons. ON PLATOON NET	90. PLATOON LEADER SCANS PLATOON SECTOR TO DETERMINE DEPLOYMENT OF OPFOR FORCE (TC SIGHT).
	10-1620	91. "BRAVO 4 ROMEO 45 THIS IS CHARLIE 5 PAPA 23 ON YOUR PUSH. READY TO SUPPORT - OVER."	

Frame: 29

SCALE:
¾"=200m



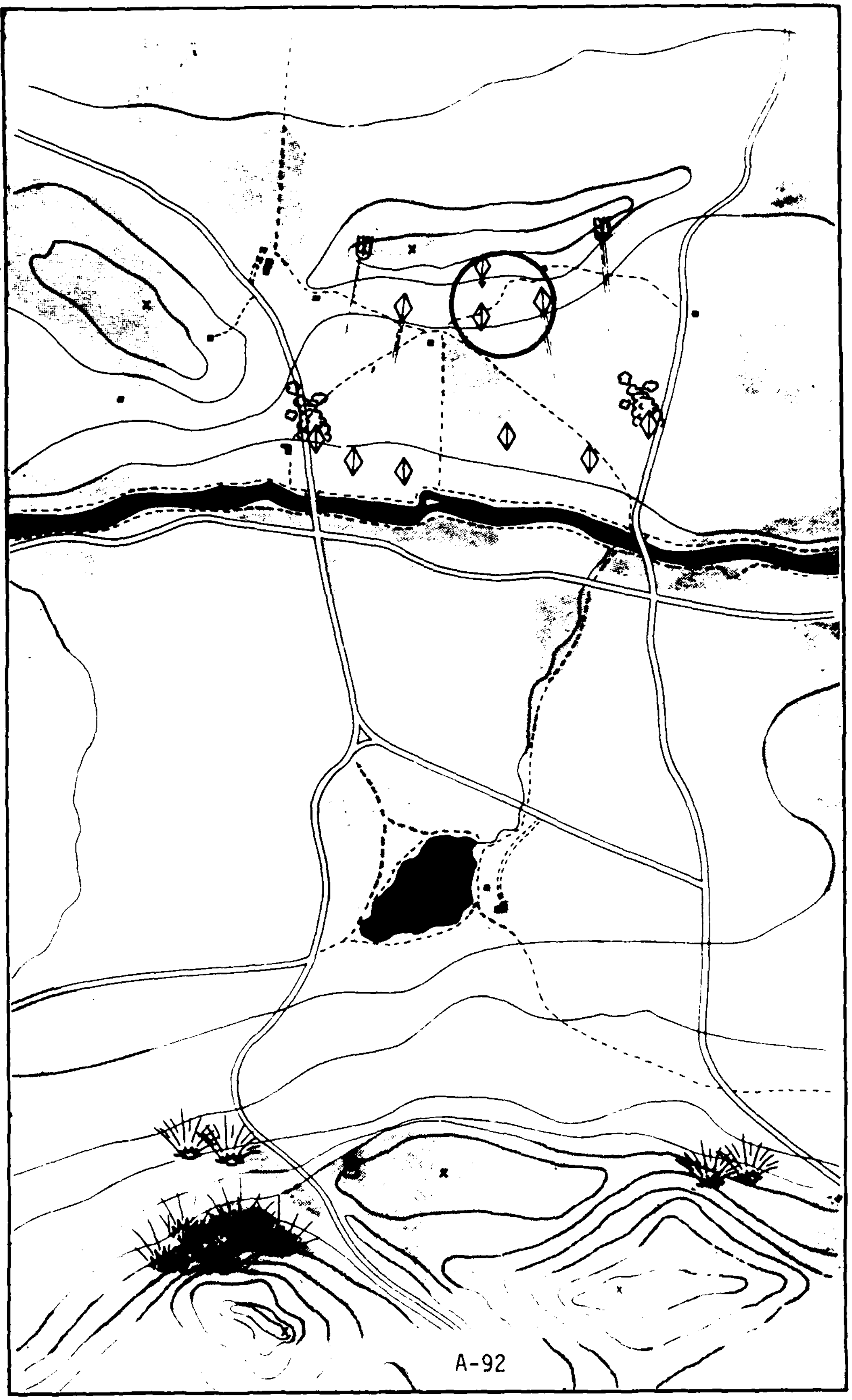
GO TO THE NEXT FRAME

Scenario 2 Frame: 30

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
OPFOR forward observer directs advanced party 122mm fire at 3rd platoon's right flank positions in response to tank fires received from that area.	30-1650	<u>DISPLAY</u> Platoon leader observes: • Three BMPs vicinity Target BRAVO. <u>NON VOICE AUDIO</u> Sound of impacting 122mm rounds - approximately 18 rounds. <u>ON PLATOON NET</u>	<u>ON PLATOON NET</u> 92. "THIS IS ROMEO 45 - ROGER. BRAVO MIKE PAPAS SOUTH OF TARGET BRAVO ARE BLUE TARGETS. VICTORS NORTH OF BRAVO ARE RED TARGETS. REQUEST YOU ENGAGE BLUE TARGETS LOCATED VICINITY OF TARGET BRAVO. CAN YOU OBSERVE - OVER?"
	5-1655	93. "THIS IS PAPA 23. CAN OBSERVE - OVER."	

Frame: 30

SCALE:
¾"=200m



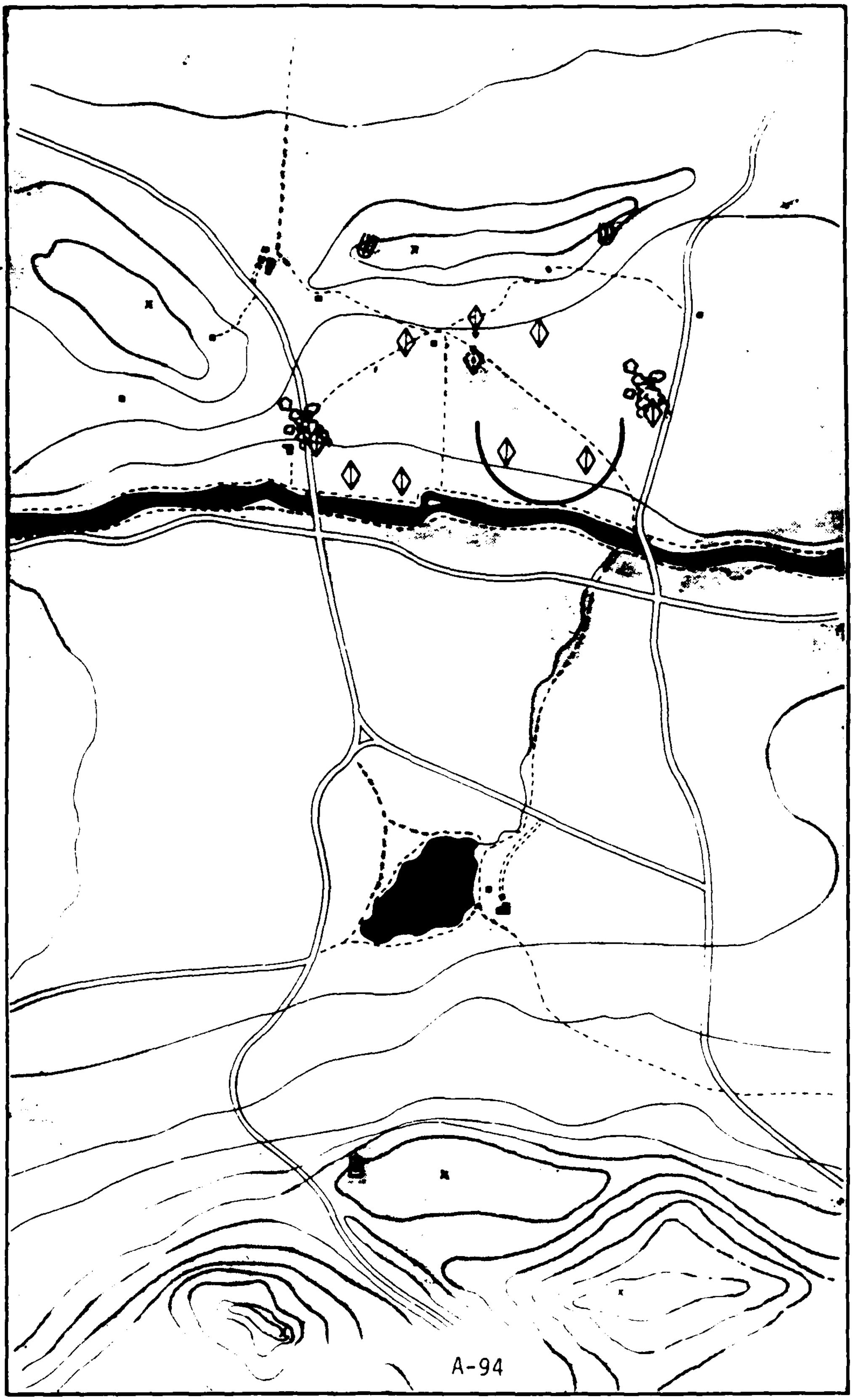
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 31**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	5-1660		94. "THIS IS ROMEO 45 ROGER. NOTIFY ME WHEN YOU LAUNCH - OVER."
	3-1663	95. "THIS IS PAPA 23. WILCO - OUT."	
	3-1666	96. "45 - THIS IS 36. BLUE BINGO - OVER."	
	7-1673		97. "THIS IS 45 - ROGER. DID YOU MONITOR MY TRANSMISSION WITH CHARLIE PAPA 23."
	2-1675	98. "36 - ROGER - OVER."	
	7-1682		99. "36 - 45. TAKE LEAD BLUE TARGETS AT THE RIVER. AT MY COMMAND. WAIT - OUT."
	3-1685	100. "ROMEO 45 - THIS IS CHARLIE PAPA 23 - LAUNCH - OUT."	
	2-1687		101. "ROMEO BLUE - FIRE - OUT."
	2-1689	NON VOICE AUDIO Sound of firing tanks.	

Frame: 31

SCALE:
¾=200m



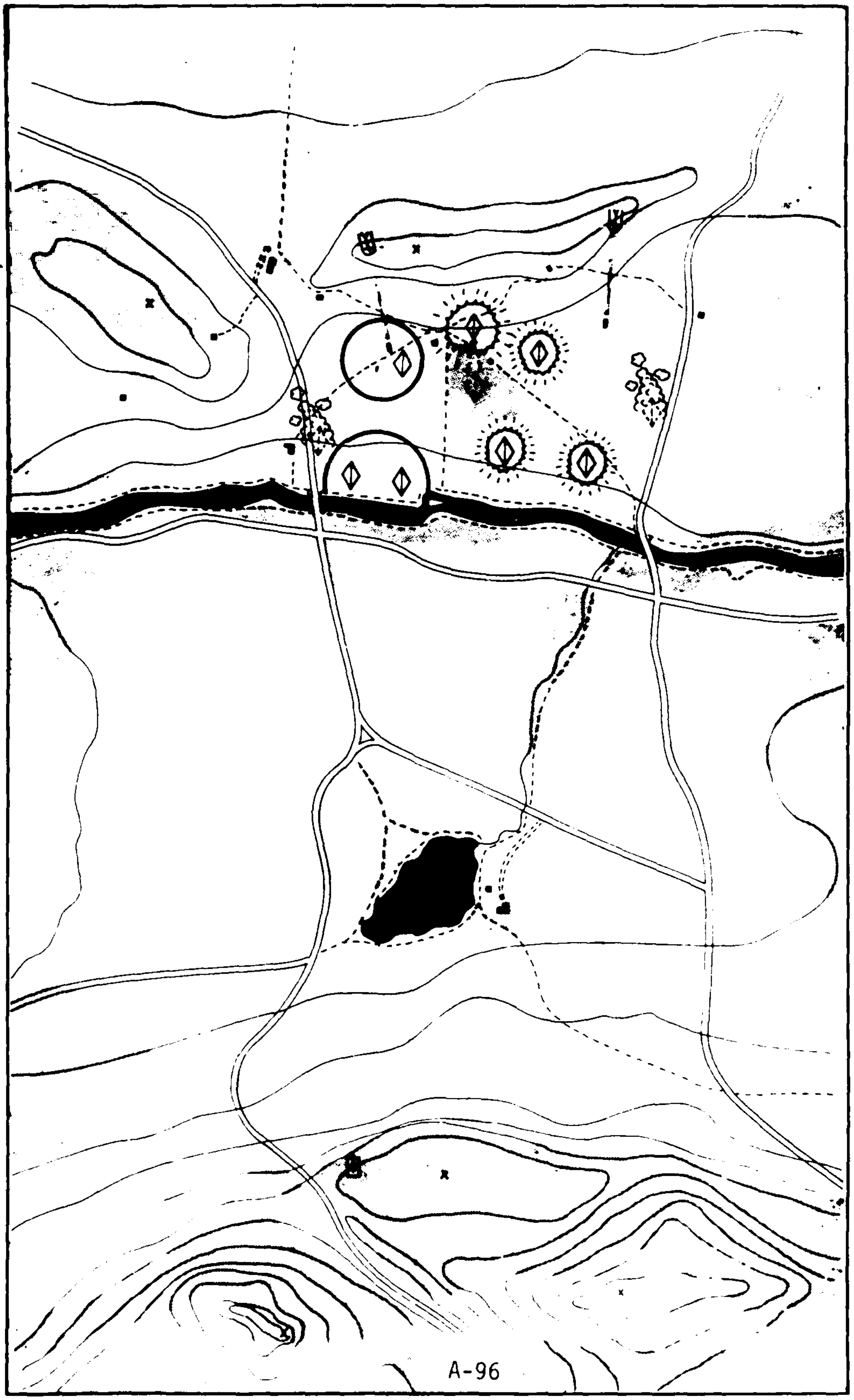
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 32**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	3-1690	102. "45 - 27. BINGO - OVER."	
	5-1695	DISPLAY Platoon leader observes: • Target locations in ROMEO RED's Sector.	103. "27 - 45. ROGER. RED TARGETS. FRONTAL. PRIORITY RIGHT AND REAR BRAVO MIKE PAPAS - OUT."
ROMEO BLUE (Section 2) obtains hits on two BMPs and displaces to new firing positions.	1692		
TOW platoon obtains hits on assigned targets and displaces to new firing positions.	1694		
OPFOR launch ATGM against ROMEO BLUE's position.	1694		

Frame: 32

SCALE:
¾"=200m



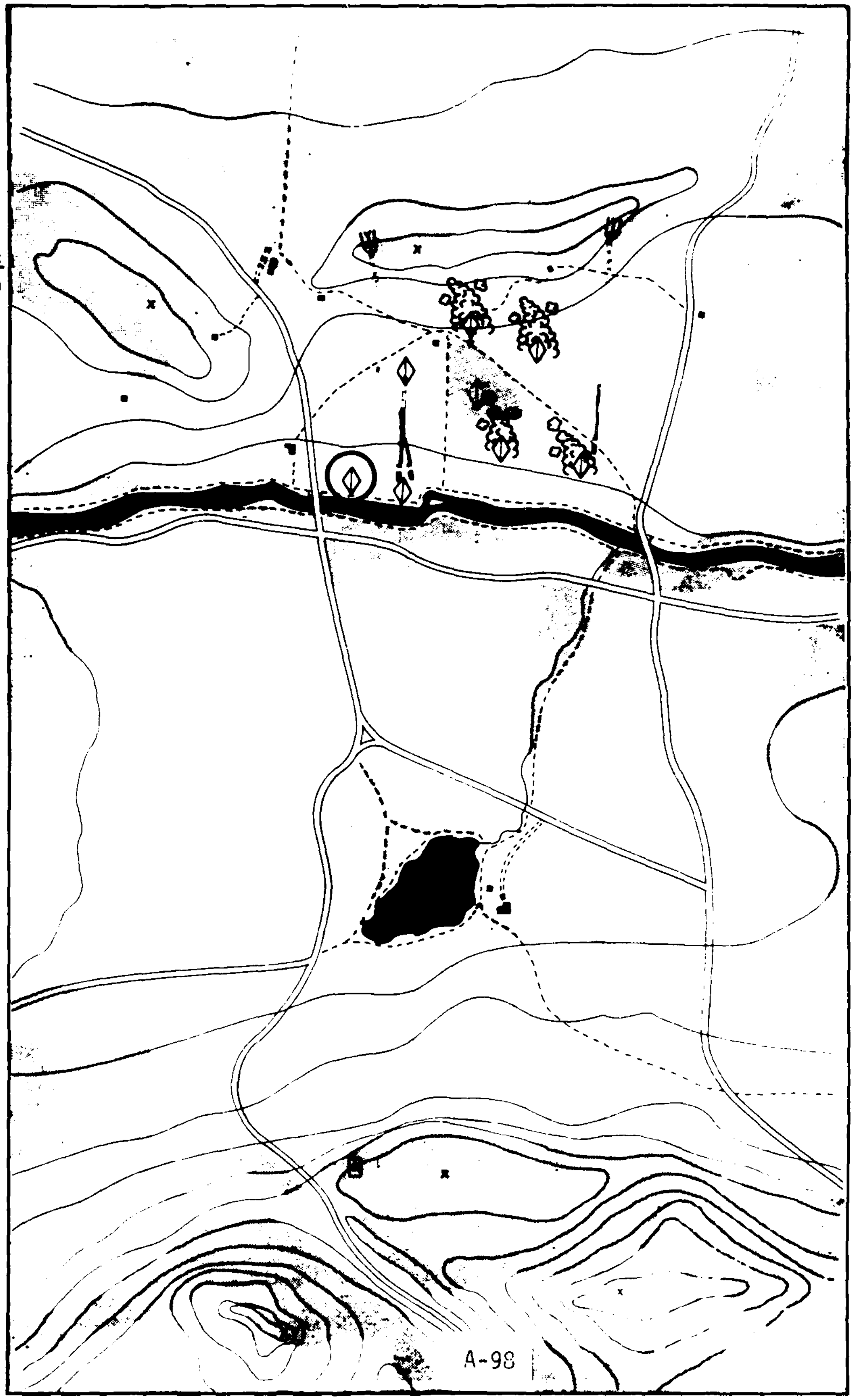
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 33

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			<u>ON INTERCOM</u>
	4-1698		104. "GUNNER - HEP. LEFT. PC (PAPA CHARLIE)."
		<u>ON INTERCOM</u>	
	3-1701	105. LOADER: "UP". GUNNER: "IDENTIFIED"	
		<u>NON VOICE AUDIO</u>	
	1702	Sound of Tank 27 firing.	
	2-1703		106. "FIRE AND ADJUST." PLATOON LEADER SCANS PLATOON SECTOR TO IDENTIFY REMAINING OPFOR TARGETS (VISION BLOCKS)
Rear BMP RED Sector, launches an ATGM.	1704		

Frame: 33

SCALE:
¾=200m



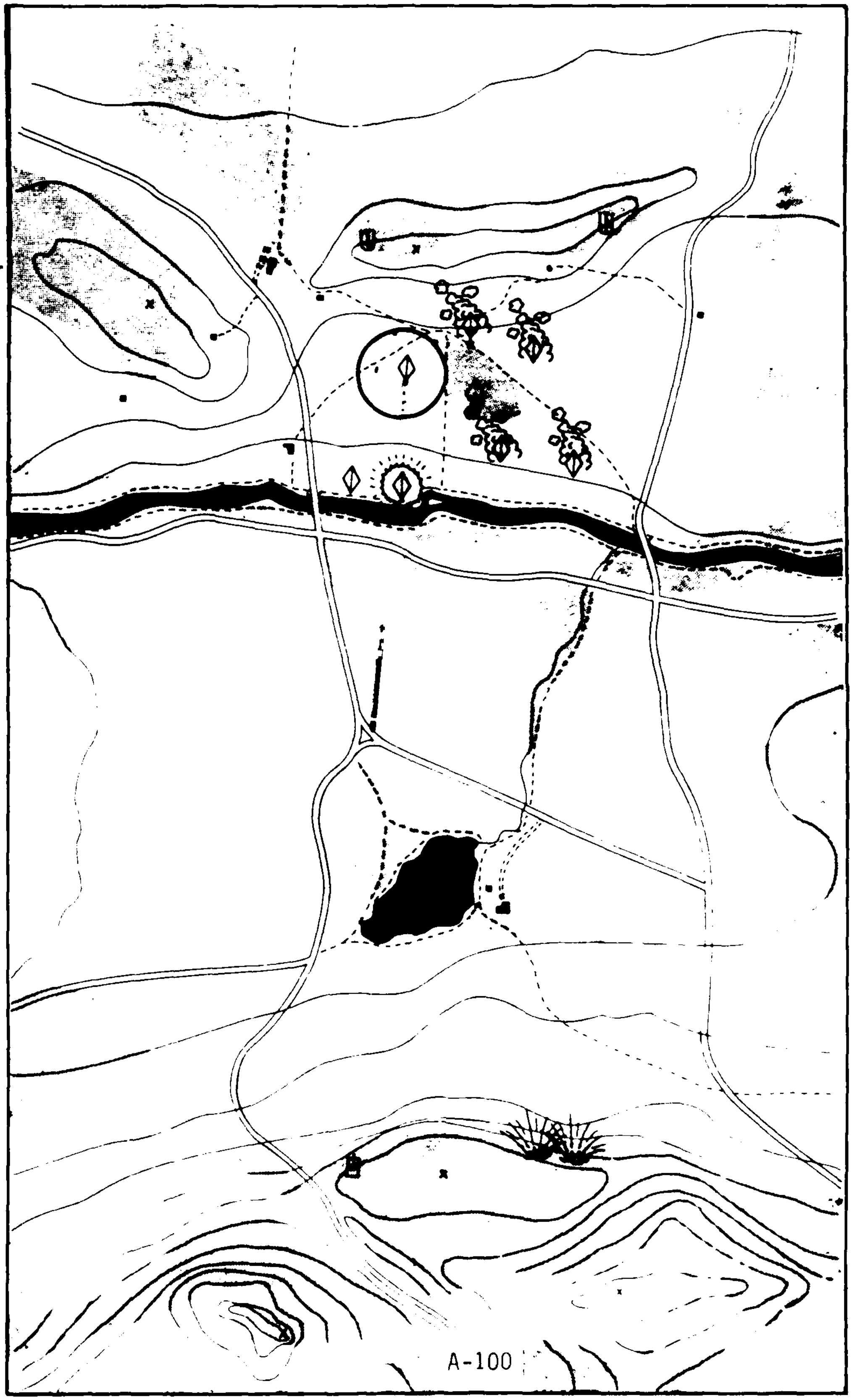
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 34

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		<u>ON PLATOON NET</u>	
	5-1708	107. "45 - THIS IS 36. TWO BRAVO MIKE PAPAS DESTROYED. BLUE IN TALLY HO - OUT."	
		<u>DISPLAY</u>	
	1707	Platoon leader observes • Rear BMP, RED Sector, firing an ATGM.	
		<u>NON VOICE AUDIO</u>	
	1707	Sound of ATGM impacting ROMEO BLUE's area.	
	1708	Sound of Tank 10 firing.	

Frame: 34

SCALE:
¾"=200m



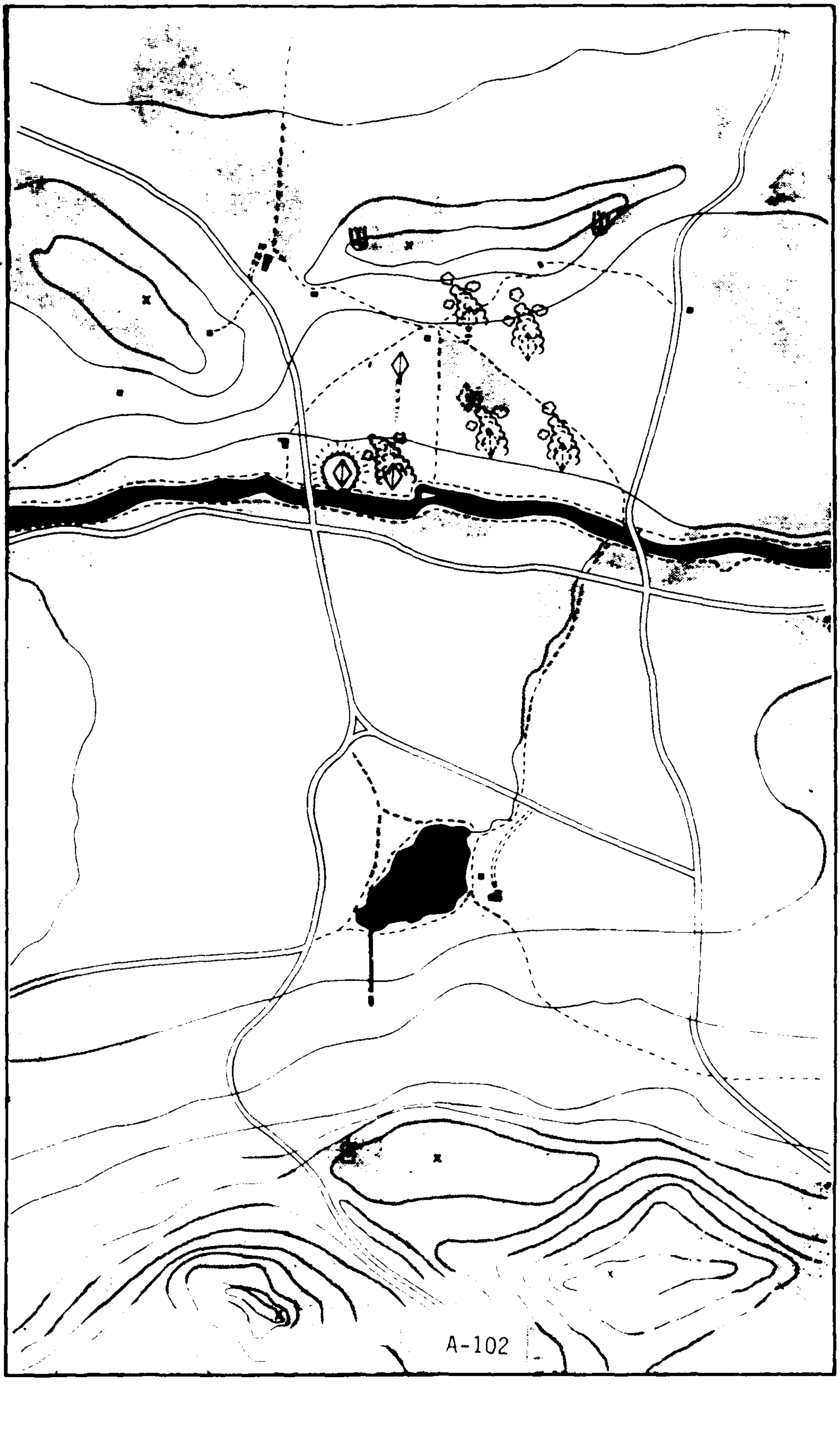
GO TO
THE NEXT
FRAME

Scenario 2 **Frame: 35**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		<u>ON INTERCOM</u>	
	2-1709	108. GUNNER. "TARGET, CEASE FIRE."	
			<u>ON INTERCOM</u>
	2-1711		109. "DRIVER - HIDE."
			<u>ON PLATOON NET</u>
	2-1713		110. "27 - 45. HIDE - OUT."

Frame: 35

SCALE:
¾=200m



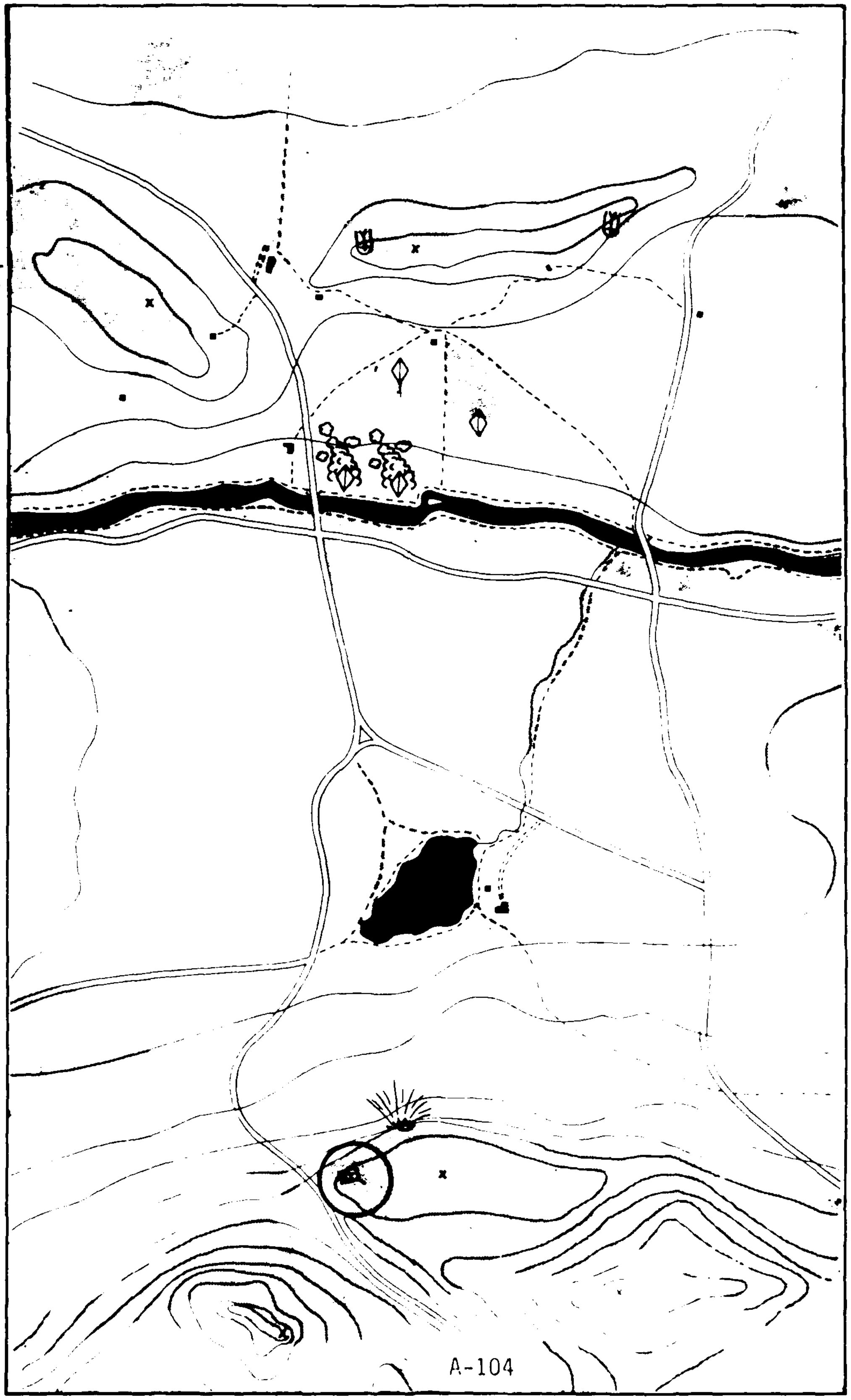
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 36

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON INTERCOM
	2-1715		111. "DRIVER - STOP."
		NON VOICE AUDIO	
	1715	ATGM impacts in vicinity of Tank 27.	
		DISPLAY	
	3-1718	Platoon leader no longer has observation of defensive sector.	
			ON INTERCOM
	2-1720		112. "DRIVER - TALLY HO LEFT."
			ON PLATOON NET
	3-1723		113. "27 - 45. TALLY HO LEFT - OVER."
		ON PLATOON NET	
	3-1726	114. "45 - 27. WILCO OUT."	

Frame: 36

SCALE:
¾=200m



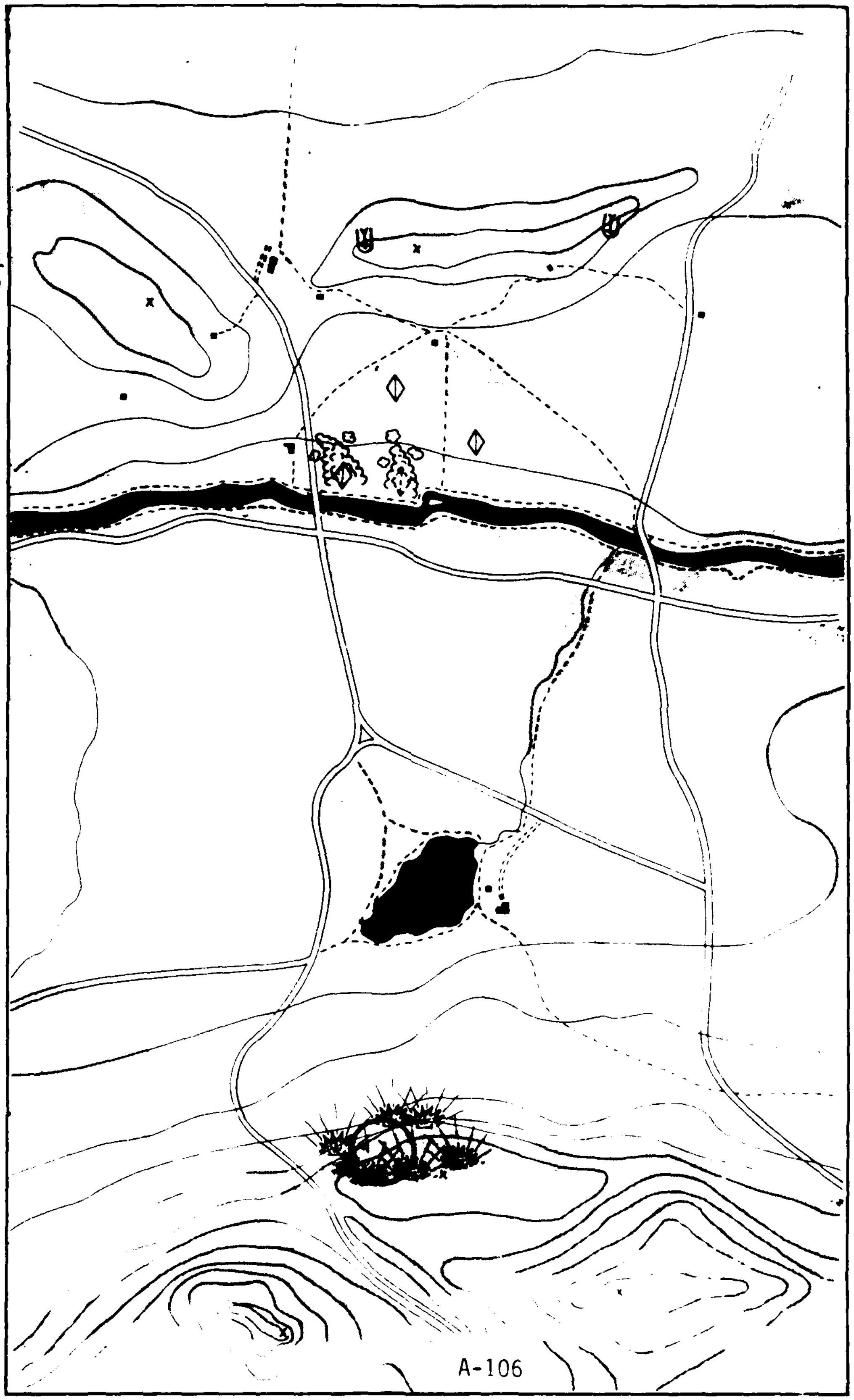
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 37

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		ON PLATOON NET	
	4-1730	115. "45 - THIS IS ROMEO 36. BLUE BINGO - OVER."	
			ON PLATOON NET
	5-1735		116. "THIS IS 45 - ROGER. TAKE BLUE AND RED TARGETS - OVER."
		NON VOICE AUDIO	
	1735-1750	Twelve rounds of 122mm impact in ROMEO RED's sector.	
		ON PLATOON NET	
	3-1738	117. "THIS IS ROMEO BLUE - WILCO - OUT."	

Frame: 37

SCALE:
¾=200m



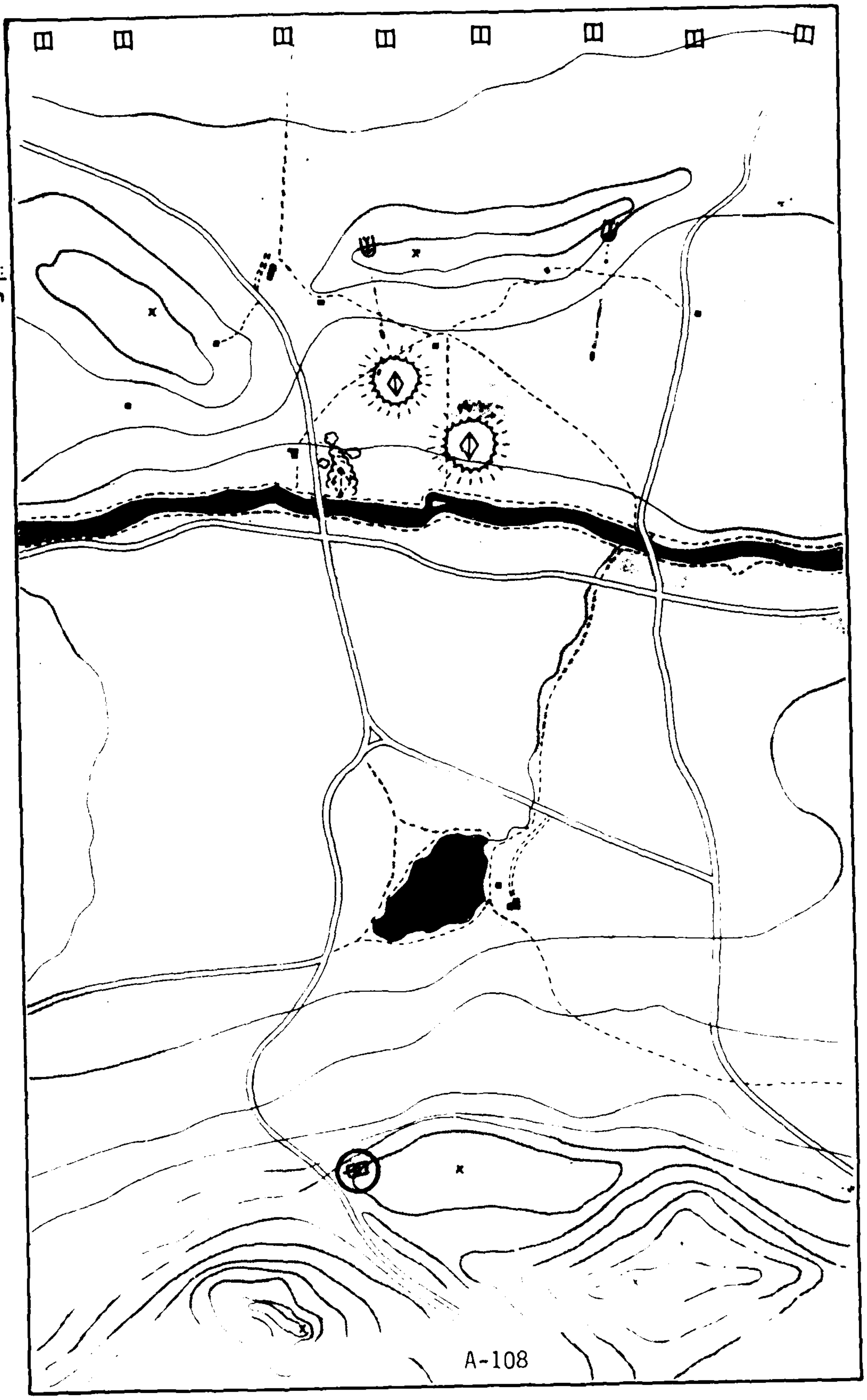
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 38

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
Platoon leader's tank continues to move to primary firing position.	1738-1761	Platoon leader does not have observation of platoon sector.	
ROMEO BLUE engages two remaining BMPs.	1743		
OPFOR launch two ATGM towards ROMEO BLUE's position.	1746		
		ON PLATOON NET	
	7-1753	118. "45 - THIS IS CHARLIE PAPA 23. BINGO. HAVE OBSERVED ALPHA TANGO LAUNCH ON ROMEO BLUE. VICINITY ZERO ONE ONE AND ALPHA ALPHA FOUR ZERO ZERO TWO. ENGAGING - OVER."	
			ON PLATOON NET
			119. "THIS IS 45 - ROGER OUT."
	7-1752	120. "ROMEO 45 - THIS IS ROMEO BLUE. TWO BRAVO MIKE PAPAS DESTROYED. IN HIDE - OUT."	

Frame: 38

SCALE:
¾ = 200m



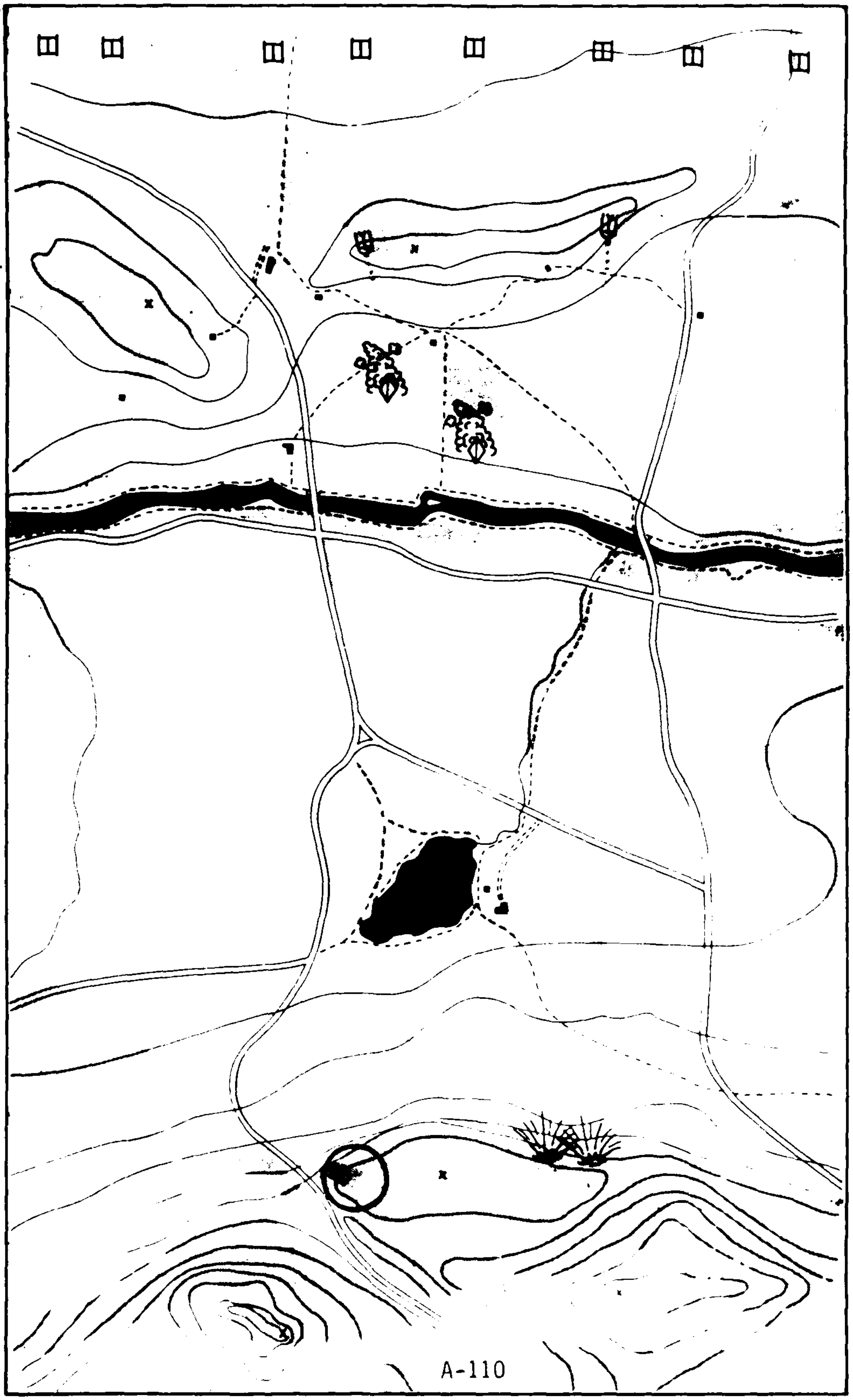
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 39

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		<u>NON VOICE AUDIO</u>	
	1758-1759	Sound of impacting ATGM.	

Frame: 39

SCALE:
¾=200m



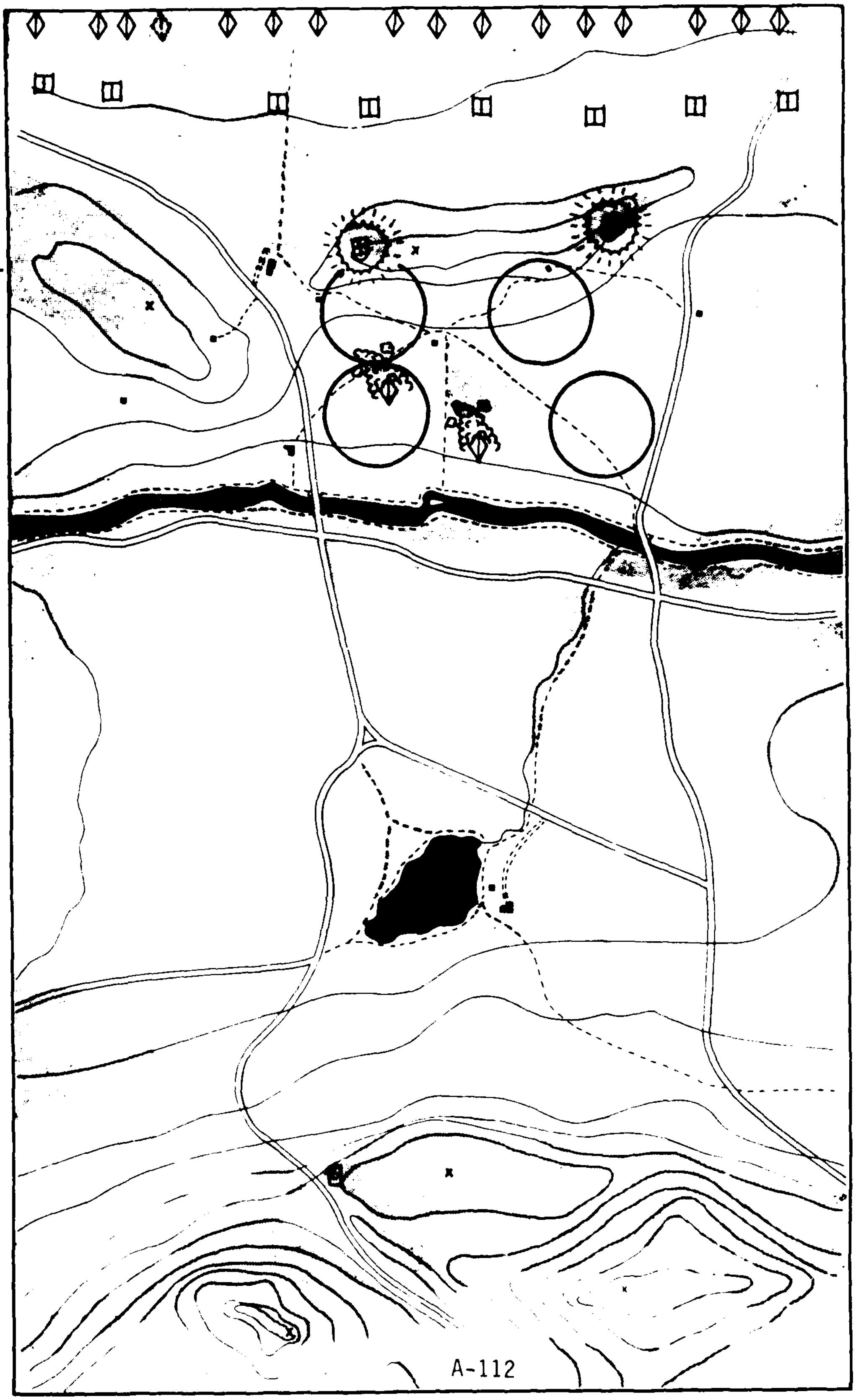
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 40

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
Platoon leader's tank arrives at primary position.	1761	DISPLAY	
	5-1766	Platoon leader observes: • No new targets west of AA4005.	121. PLATOON LEADER SCANS PLATOON SECTOR TO DETERMINE SITUATION.
TOW platoon obtains hits on two ground mounted ATGM.	1764	ON PLATOON NET	
	3-1767	122. "ROMEO 45 - THIS IS CHARLIE 5 PAPA 23 OVER."	ON PLATOON NET
	2-1769		123. "THIS IS 45 - OVER."
	30-1799	124. "THIS IS 23 - TWO GROUND MOUNTED ALPHA TANGO MIKES VICINITY ZERO ZERO ONE AND ALPHA ALPHA FOUR ZERO ZERO FIVE DESTROYED. HAVE OBSERVED SEVEN TANGO EIGHTIES AND FIFTEEN TO TWENTY BRAVO MIKE PAPAS, TWO HUNDRED MIKES EAST OF ALPHA ALPHA FOUR ZERO ZERO FIVE AND EXTENDING ACROSS SALLY AND JANE - OVER."	
	5-1804		125. "THIS IS 45 - ROGER. ENGAGE RED AND BLUE TARGETS. PRIORITY TANKS - OVER."
	2-1806	126. THIS IS 23 - WILCO - OUT.	

Frame:40

SCALE:
¾=200m



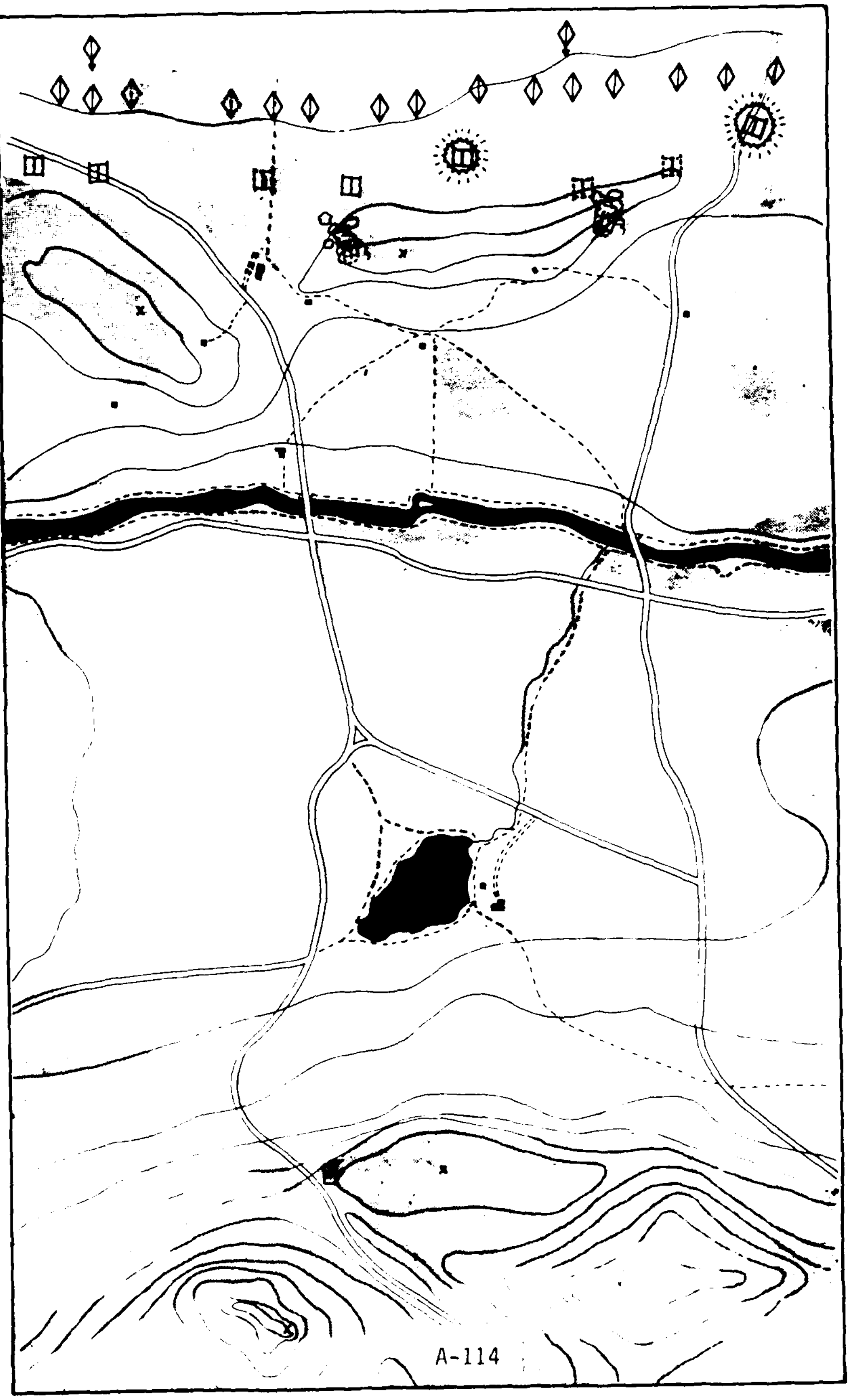
GO TO
THE NEXT
FRAME

Scenario 2 Frame: 41

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON COMPANY NET
	5-1811		127. "YANKEE 51 - THIS IS ROMEO 45. STA-REP - OVER."
		ON COMPANY NET	
	3-1814	128. "THIS IS YANKEE 51 - OVER."	
	30-1844		129. THIS IS ROMEO 45. TIME NOW ___. LINE CHARLIE ___. TEN BRAVO MIKE PAPA'S AND TWO GROUND MOUNTED ALPHA TANGO GULF MIKES DESTROYED. CHARLIE PAPA 23 REPORTS APPROXI-MATELY SEVEN TANGO EIGHTIES AND TWENTY BRAVO MIKE PAPAS NORTH OF ALPHA ALPHA FOUR ZERO ZERO TWO MOVING TOWARDS SALLY AND JANE. LINE DELTA - NONE. LINE ECHO - REQUEST SERRIA ALPHA BRAVO OSCAR TANGO. HOME PLATE ONE BY ONE. LINE HOTEL - HAVE DIRECTED CHARLIE PAPA 23 TO ENGAGE TANGO EIGHTIES IN SALLY. OTHER LINES NO CHANGE - OVER.
	5-1849	130. THIS IS YANKEE 51 - ROGER - WAIT - OUT.	

Frame:41

SCALE:
¾"=200m



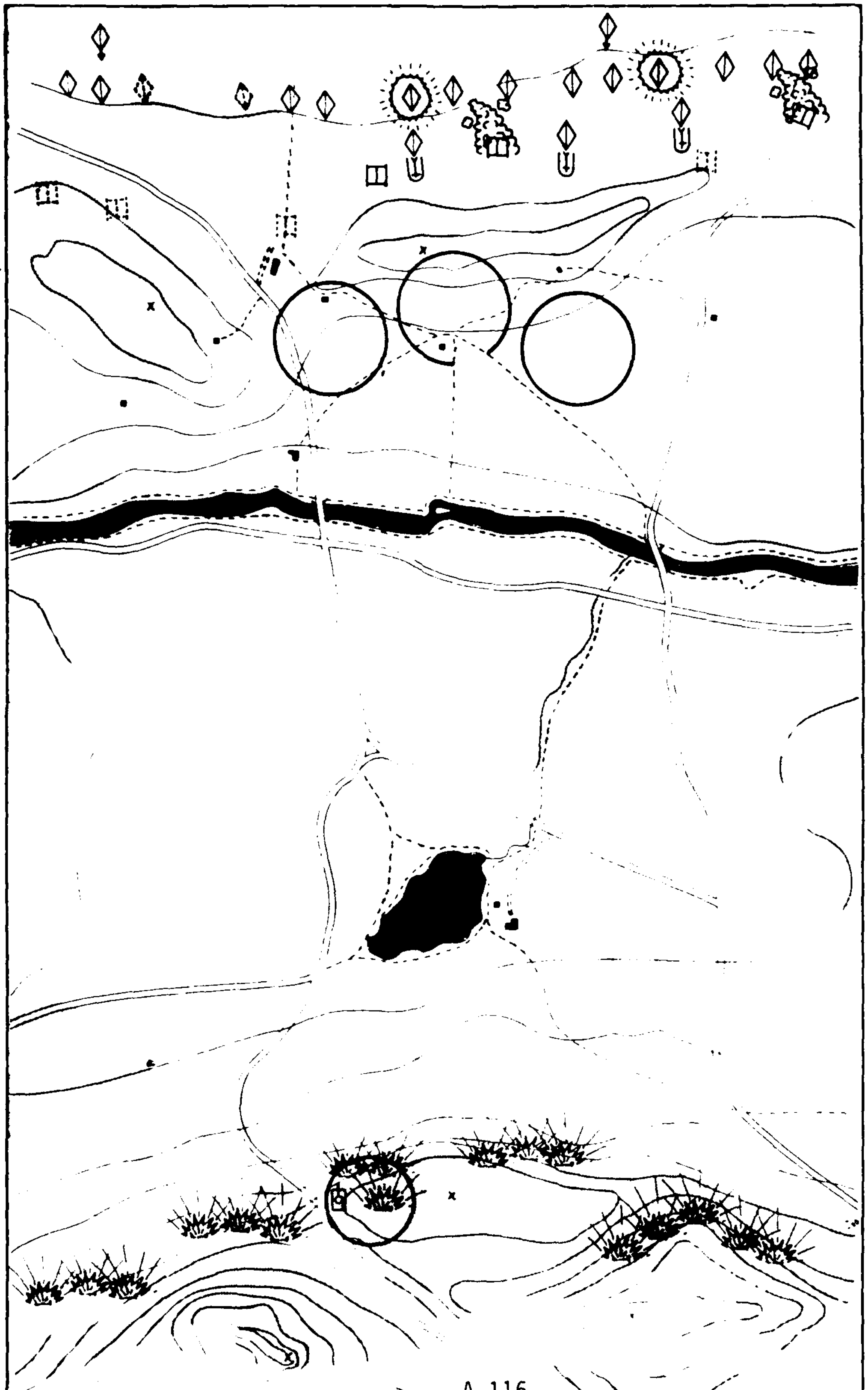
GO TO
THE NEXT
FRAME

Scenario 3 Frame: 1

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	00		PLATOON LEADER SCANS PLATOON SECTOR.
		<u>ON COMPANY NET</u>	
TOW platoon obtains hits on two BMPs.	10 - 10	1. "45 - THIS IS YANKEE 51. REQUEST YOU LAY DOWN CANDY AND USE TANGO INDIA SERRIA TO ENGAGE - OVER."	<u>ON COMPANY NET</u>
	5 - 15		2. "THIS IS 45 - WILCO - OUT."
		<u>ON PLATOON NET</u>	
	3 - 18	3. "45 - THIS IS CHARLIE 5 PAPA 23.	<u>ON COMPANY NET</u>
	2 - 20		4. "23 - 45."
	15 - 35	5. "THIS IS 23 - TWO TANGO EIGHTIES AND TWO BRAVO MIKE PAPAS DESTROYED. LEAD TANGOS NOW VICINTIY ALPHA ALPHA FOUR ZERO ZERO FIVE. TALLY HO - OVER."	
	5 - 40		6. "THIS IS 45 - ROGER - REPORT BINGO - OUT."
OPFOR 122mm howitizers begin successive fire concentration (SPO) against company defensive positions.	2 - 42	<u>DISPLAY</u> Three 122mm rounds impact in front, left, and right of tank 10. <u>NON VOICE AUDIO</u>	
	42-79	Sound of numerous 122mm impacting along platoon front.	

Frame: 1

SCALE:
¾"=200m



GO TO
THE NEX
FRAME

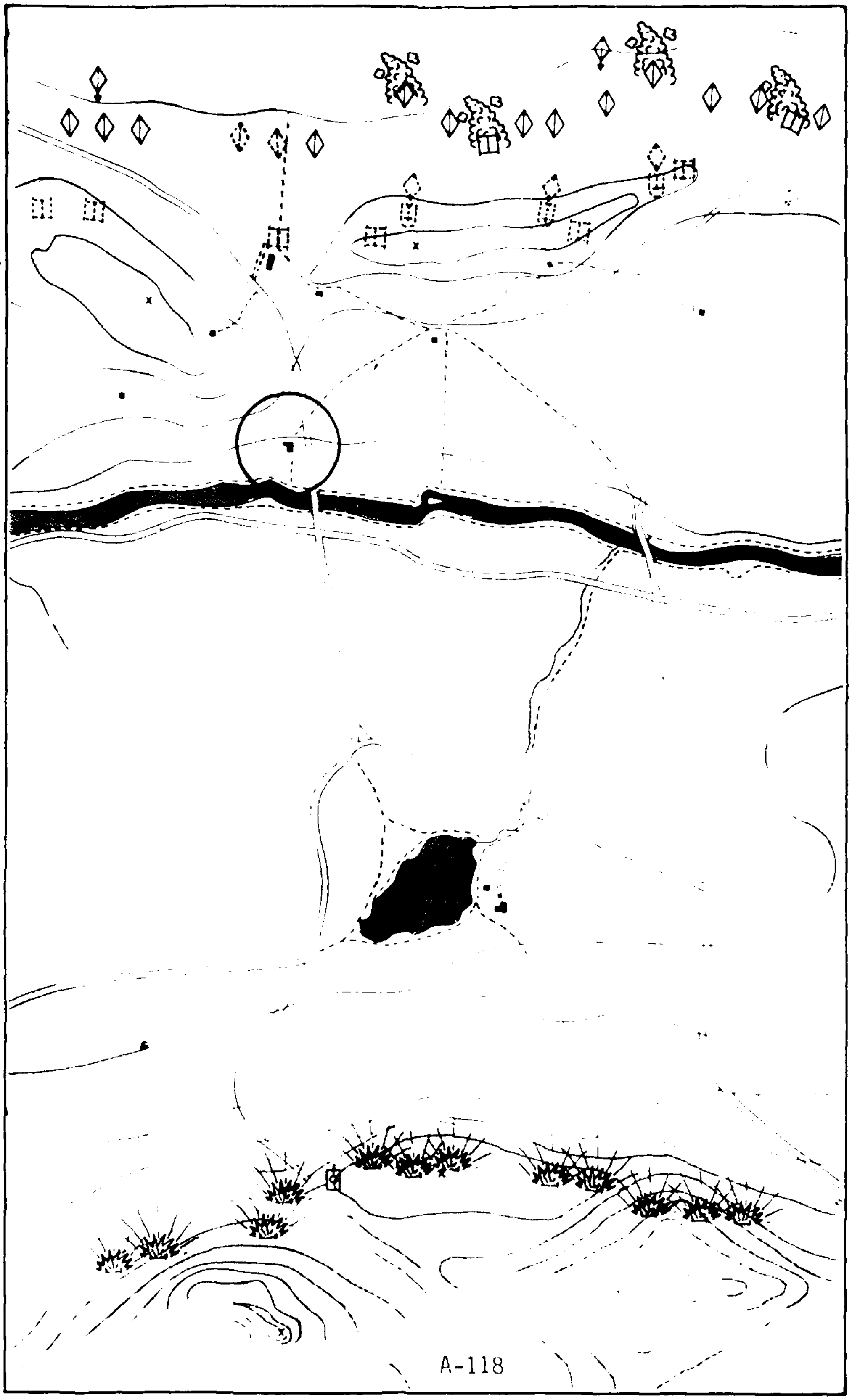
Scenario 3

Frame: 2

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON FIRE CONTROL NET
	10 - 50		7. ALPHA 8 CHARLIE 42 - THIS IS BRAVO 4 ROMEO 45. ADJUST FIRE. SHIFT ALPHA ALPHA FOUR ZERO ZERO NINER - OVER."
		ON FIRE CONTROL NET	
	5 - 55	8. "THIS IS ALPHA 8 CHARLIE 42. SHIFT ALPHA ALPHA FOUR ZERO ZERO NINER - OUT."	
	3 - 58		9. "DIRECTION ONE SIX HUNDRED - DROP ONE HUNDRED - OVER."
	4 - 62	10. "DIRECTION ONE SIX HUNDRED - DROP ONE HUNDRED - OVER."	
	3 - 65		11. "ADJUSTING FOR CANDY - OVER."
	5 - 70	12. "ROGER - ADJUSTING FOR CANDY. AUTHENTICATE BRAVO DELTA - OVER."	
	4 - 74		13. "THIS IS 45 - I AUTHENTICATE ZULU - OVER."
	3 - 77	14. "ROGER, MISSION WORKING - OUT."	

Frame: 2

SCALE:
¼ = 200m



GO TO THE NEX FRAME

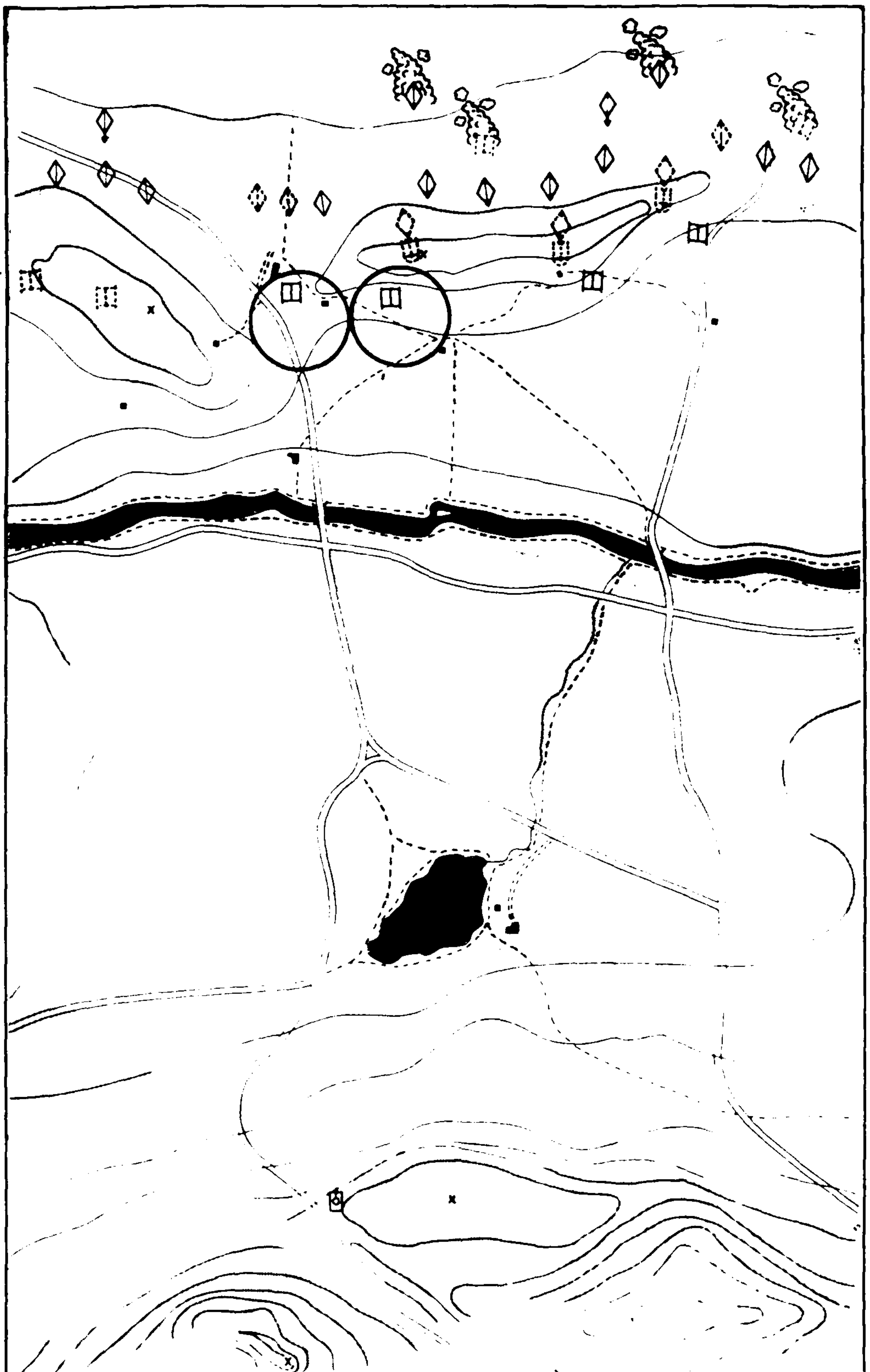
Scenario 3

Frame: 3

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
122mm fire stops.	79		ON PLATOON NET
	3 - 80		15. "ROMEO - THIS IS ROMEO 45 - OVER."
		ON PLATOON NET	
	5 - 85	16. "THIS IS ROMEO 27 - OVER." "45 - 36 - OVER." "45 - 64 - OVER."	
	29 - 114		17. "THIS IS 45 - APPROXIMATELY SEVEN TANGO EIGHTIES AND FIFTEEN BRAVO MIKE PAPAS APPROACHING SALLY. BE PREPARED FOR CANDY SOUTH FROM ZERO ZERO NINER. USE TANGO INDIA SIERRA. PRIORITY TANGOS IN CANDY. RED ON RED BLUE ON BLUE. AT MY COMMAND - OVER."
	6 - 120	18. "THIS IS 27 - WILCO - OUT." "45 - 36 - WILCO - OUT." "45 - 64 - WILCO - OUT."	
	5 - 125	DISPLAY	18. PLATOON LEADER SWITCHES BACK. TO THE FIRE CONTROL NET AND SCANS PLATOON SECTOR (TC SIGHT).
		ON FIRE CONTROL NET	
Round on the way.	3 - 127	19. "45 - CHARLIE 42. SHOT - OVER."	ON FIRE CONTROL NET
	2 - 130		20. "SHOT - OUT."
Projectile flight time.	15 - 145		

Frame:3

SCALE:
¼=200m



A-120

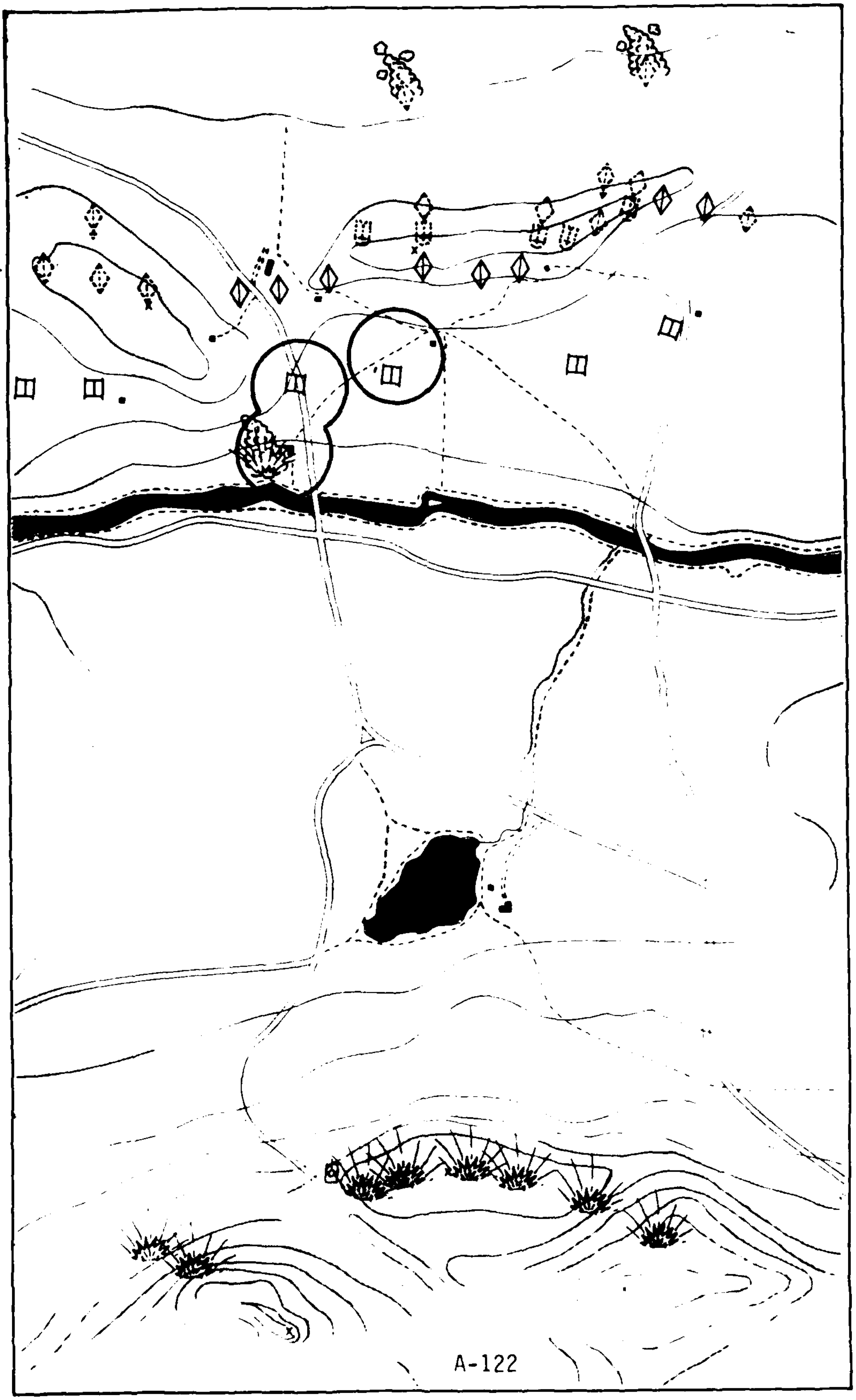
GO TO
THE NEXT
FRAME

Scenario 3 **Frame: 4**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		NON VOICE AUDIO	
OPFOR artillery resumes successive fire concentration.	130 190	Numerous 122mm rounds fall out platoon's immediate rear.	
		ON DISPLAY	
Deviation correction is small.	6 - 151	Platoon leader observes: ● Round as range correct - left.	21. "CHARLIE 42 - THIS IS ROMEO 45. FIRE FOR EFFECT. BATTERY TWO. REQUEST CANDY - OVER."
		ON FIRE CONTROL NET	
Fire mission working	7 - 158	22. "THIS IS CHARLIE 42 - FIRE FOR EFFECT. BATTERY TWO. CANDY. WAIT - OUT."	
			ON COMPANY NET
	10 - 168		23. "BRAVO 4 MIKE 29 - THIS IS BRAVO 4 ROMEO 45. USING CANDY IN SALLY. MAY EFFECT NANCY - OVER."
		ON COMPANY NET	
	3 - 171	24. "THIS IS MIKE 29 - ROGER - OUT."	
	6 - 177	DISPLAY	25. PLATOON LEADER SWITCHES TO FIRE CONTROL NET. OBSERVES TRP 010. QUICKLY SCANS OWN SECTOR."
Rounds on the way.	179	ON FIRE CONTROL NET	
	3 - 180	26. "ROMEO 45 - SHOT - OVER."	
	2 - 182		27. "SHOT - OUT."
			ON INTERCOM
	6 - 188		28. "GUNNER - SABOT. MOVING TANK FIRE AND ADJUST AT MY COMMAND."
		ON INTERCOM	
	3 - 191	29. LOADER: "UP." GUNNER: "INDENTIFIED."	

Frame: 4

SCALE:
¼=200m



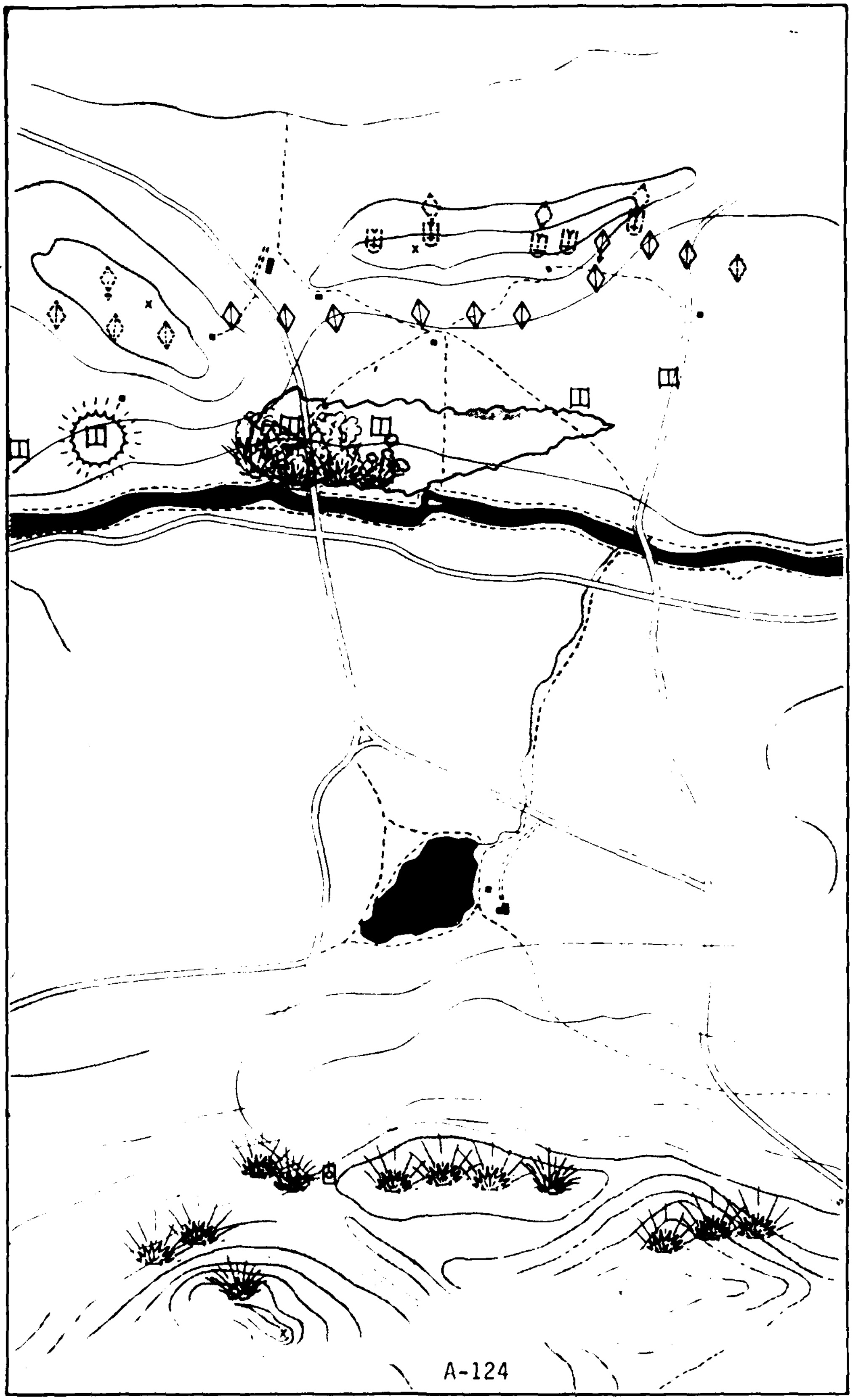
GO TO
THE NEXT
FRAME

Scenario 3 Frame: 5

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
Five smoke rounds impact in the vicinity of TRP 009. The two T-80s in the RED sector are in the screen.	10 - 201	DISPLAY Platoon leader observes: ● Smoke screen fully covers two T-80s in RED Sector	30. PLATOON LEADER OBSERVES EFFECTS OF SMOKE SCREEN (VISION BLOCKS) ON INTERCOM
	2 - 202		"GUNNER - FIRE AND ADJUST" ON PLATOON NET
	3 - 206		31. "ROMEO 27 - THIS IS 45. FIRE - OUT."
		NON VOICE AUDIO	
	211	Sound of tanks 10 and 11 firing.	
Third platoon tanks score a hit on a T-80.	5 - 211	ON PLATOON NET 32. "ROMEO 45 - THIS IS CHARLIE PAPA 23. BINGO - OVER."	
	2 - 213		33. "23 - 45. WAIT - OUT."

Frame: 5

SCALE:
¾"=200m



GO TO
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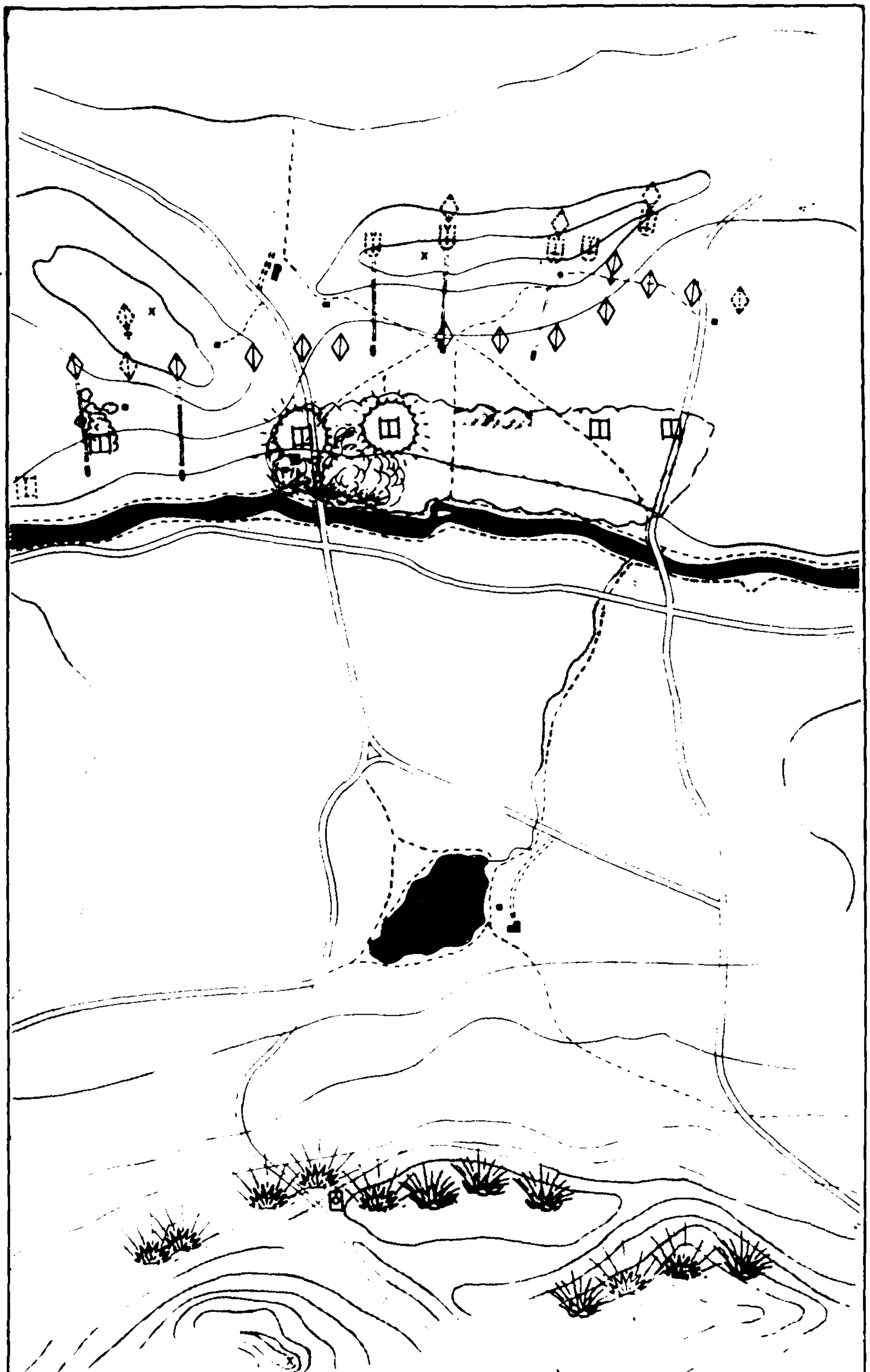
FRAME

Scenario 3 Frame: 6

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
Charlie 42 fires second volley of smoke.	213-238		
	213	DISPLAY Platoon leader observes: ● Smoke screen carrys across BLUE targets. ● Second volley impacts vicinity TRP 009.	
OPFOR BMPs launch ATGM against 3rd Platoon position.	215		
	4 - 217		ON PLATOON NET 34. "ROMEO BLUE - THIS IS 45. FIRE - OUT."
Tanks 10 and 11 (RED section) achieve first round hits on two T-80s.	3 - 220	ON INTERCOM 35. GUNNER - "TARGET CEASE FIRE."	
Tanks 12 and 13 engage targets.	221-223		
OPFOR ATGM in support position launch against ROMEO RED.	2 - 222		ON INTERCOM 36. "DRIVER - HIDE."
	3 - 225		37. "DRIVER - MOVE TO ALTERNATE POSITION."

Frame: 6

SCALE:
¾ = 200m



GO TO
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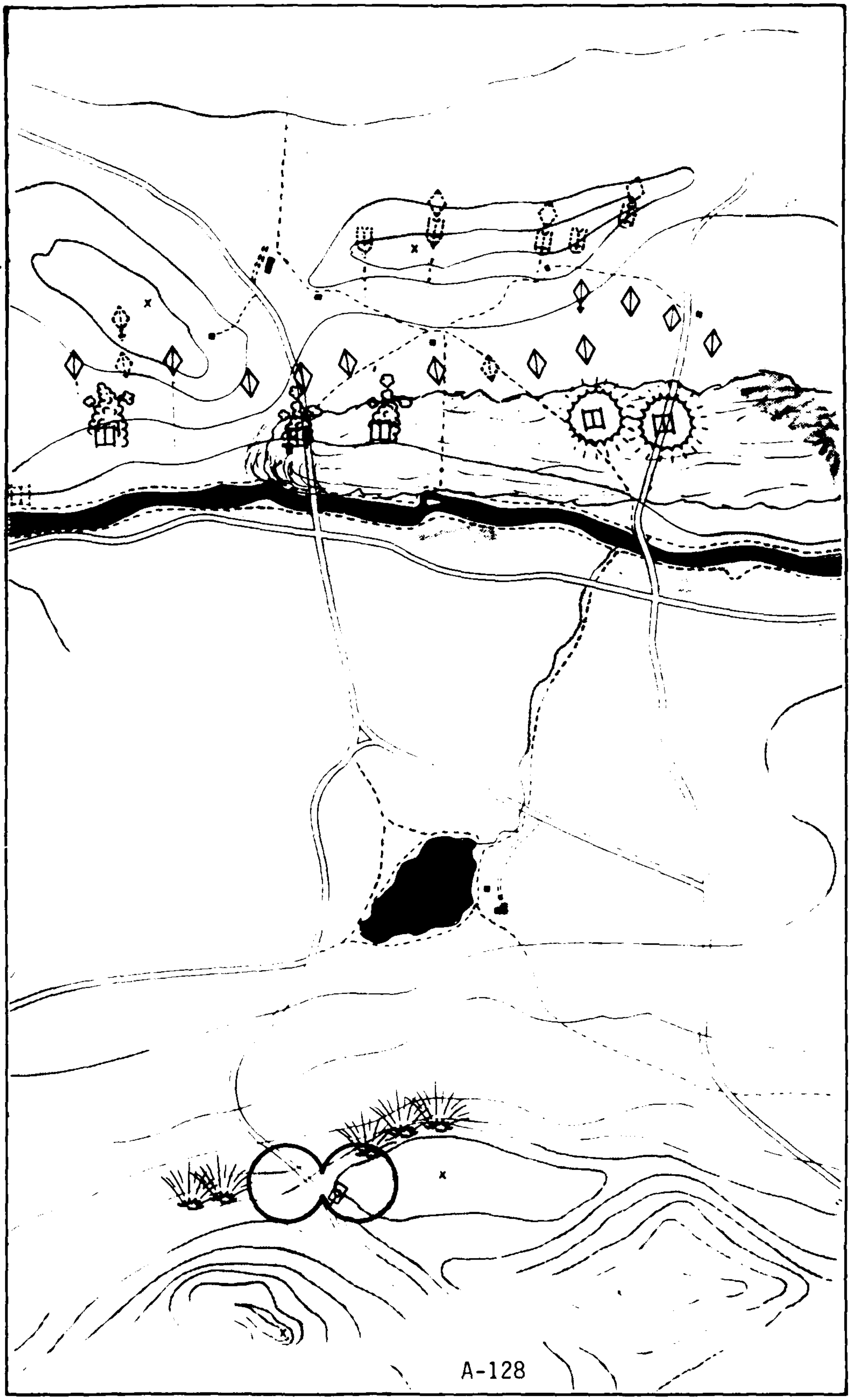
FRAME

Scenario 3 Frame: 7

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
Platoon leader's tank moves to alternate position	225-310		
ROMEO BLUE achieves hits on two T-80s.	226		
OPFOR ATGM impact at 3rd platoon's flank positions.	228		
		ON PLATOON NET	
	3 - 223	38. "45 - 27 TARGET DESTROYED. TALLY HO - OUT."	
			ON FIRE CONTROL NET
	3 - 231		39. "CHARLIE 42 - THIS IS ROMEO 45 - OVER."
		ON FIRE CONTROL NET	
OPFOR ATGM impact at ROMEO RED's vacated firing positions.	2 - 233 236	40. "THIS IS 42 - OVER."	
	17 - 250		41. "THIS IS 45 - END OF MISSION. SCREEN WILL CARRY FROM ZERO ZERO NINER TO ZERO ONE THREE. PERFECT. REQUEST YOU BE PREPARED TO REPEAT FIRE FOR EFFECT AT MY RE-QUEST - OVER."
	5 - 255	42. "THIS IS 42 - ROGER. TARGET DESIGNATION IS ALPHA ALPHA FOUR ZERO ONE SIX."	
TOW platoon leader now controlling platoon fires by section. Company commander has directed TOW ppatoon leader to also reinforce 3rd platoon fires.	255		
	2 - 252		43. "ROGER - OUT."

Frame 7

SCALE:
½=200m



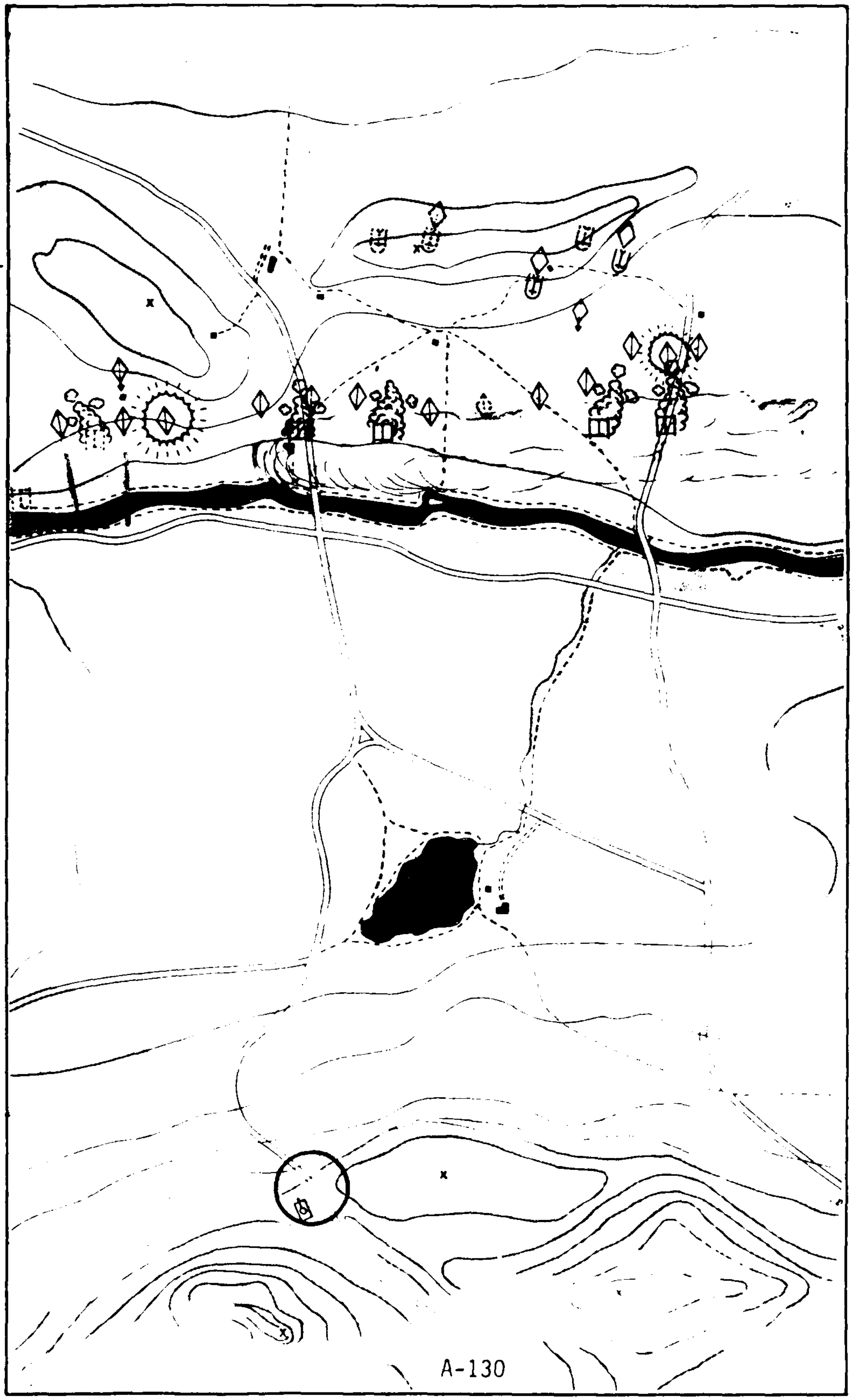
GO TO
THE NEXT
FRAME

Scenario 3 Frame: 8

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		ON PLATOON NET	
	7 - 264	44. "ROMEO 45 - THIS IS ROMEO 36. TWO TANGO EIGHTIES DESTROYED. TALLY HO. WILL REPORT BINGO - OUT."	
TOW platoon achieves a hit on a BMP in Romeo BLUE's sector.	267		
			ON PLATOON NET
	4 - 268		45. "CHARLIE PAPA 23 - THIS IS ROMEO 45 - OVER."
		ON PLATOON NET	
	2 - 270	46. "THIS IS PAPA 23 - OVER."	
	4 - 274		47. "THIS IS 45 - REPORT EFFECT OF CANDY ON YOUR OBSERVATION."
TOW platoon achieves a hit on a BMP located *on 1st and 3rd platoon* boundary.	275		
	30 - 304	48. "THIS IS PAPA 23 - HAVE DESTROYED A BRAVO MIKE PAPA. IF WIND HOLDS WILL BE ABLE TO CONTINUE ENGAGING TARGETS OVER CANDY, VICINITY ALPHA ALPHA FOUR ZERO ZERO TWO. WEIGHT OF ATTACK IN BLUE. OBSERVE APPROXIMATELY SIX BLUE BRAVO MIKE PAPAS AND THREE RED. NO TANGO EIGHTIES - ATGM VICINITY ALPHA ALPHA FOUR ZERO ZERO FIVE AND ZERO ONE ONE. BREAK. AM ALSO SUPPORTING BRAVO 4 GOLF 17 - OVER."	
OPFOR BMPs launch ATGMs against 3rd platoon position.	4 - 308		49. "THIS IS 45 - ROGER. PRICRITY IN SALLY IS BLUE'S TARGETS."

Frame: 8

SCALE:
¾ = 200m



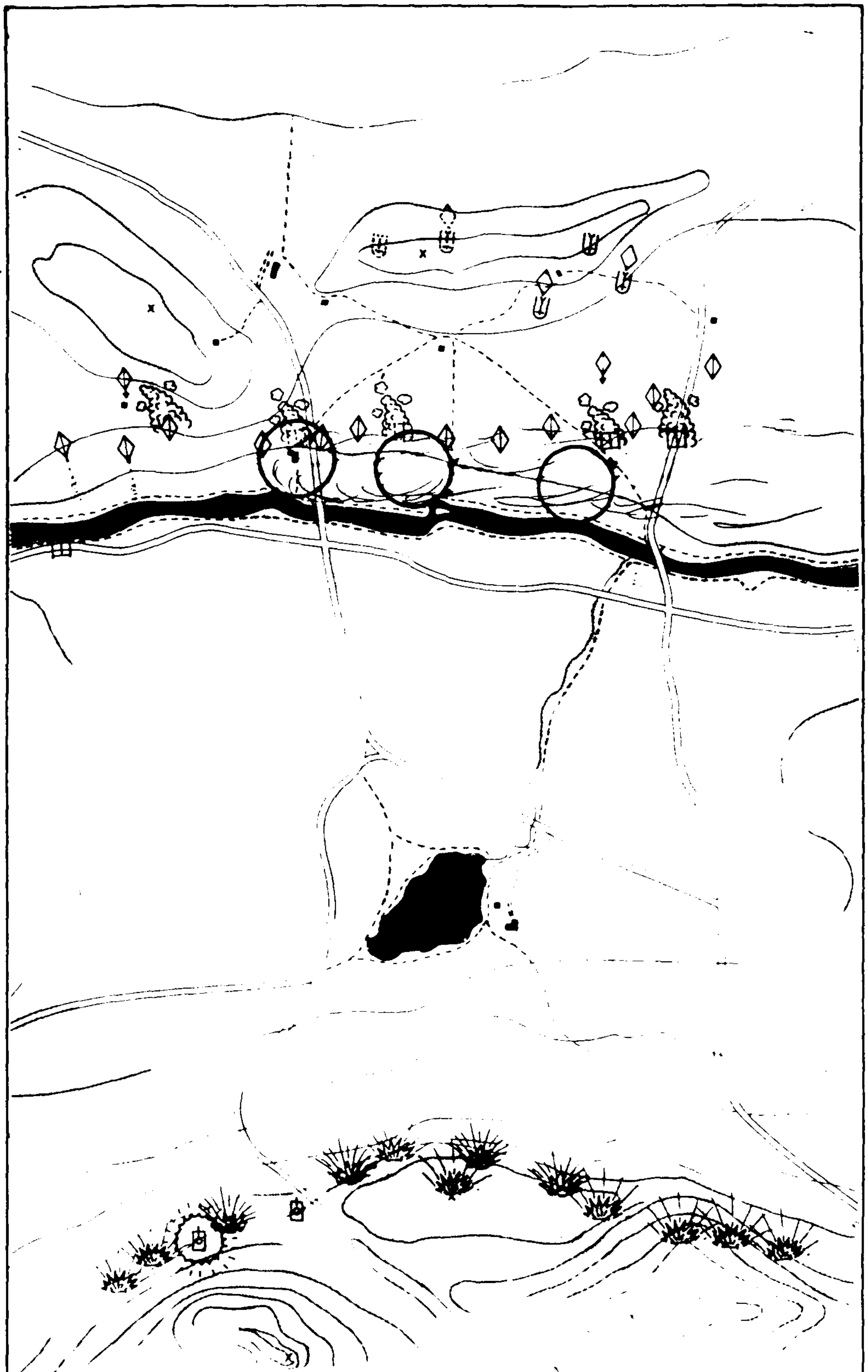
GO TO
THE NEXT
FRAME

Scenario 3 — Frame: 9

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
Platoon leader's tank arrives in alternate position.	310	DISPLAY	50. PLATOON LEADER CHECKS SMOKE SCREEN AND TARGETS IN HIS SECTOR. OBSERVES HIGH GROUND. SEE BMP WITH SAGGER (TC SIGHT).
	10 - 320	Platoon leader observes: • Artillery impacting immediate front.	
OPFOR ATGM scores a hit on 3rd platoon's right flank tank.	321	NON VOICE AUDIO Platoon leader hears loud explosion at his left flank. Sound of 122mm artillery impacting is continuous.	ON FIRE CONTROL NET
	7 - 328		51. "ALPHA 8 CHARLIE 42 - THIS IS ROMEO 45. ADJUST FIRE. - SHIFT ALPHA ALPHA FOUR ZERO ZERO FIVE - OVER."
		ON FIRE CONTROL NET	
	4 - 332	52. "THIS IS CHARLIE 42 - SHIFT ALPHA ALPHA FOUR ZERO ZERO FIVE - OVER."	
OPFOR artillery resumes successive fire concentration.	334		
TOW platoon continues to engage by section.	336		
	4 - 336		53. "DIRECTION ONE SIX TWO ZERO. DROP ONE HUNDRED - OVER."
	4 - 337	54. "DIRECTION ONE SIX TWO ZERO. DROP ONE HUNDRED - OVER."	
	2 - 339		55. "ADJUSTING FOR CANDY - OVER."
	4 - 341	56. "ADJUSTING FOR CANDY. AUTHENTICATE ROMEO JULIET - OVER."	
	3 - 344		57. "THIS IS 45 - I AUTHENTICATE OSCAR - OVER."

Frame: 9

SCALE:
¼=200m



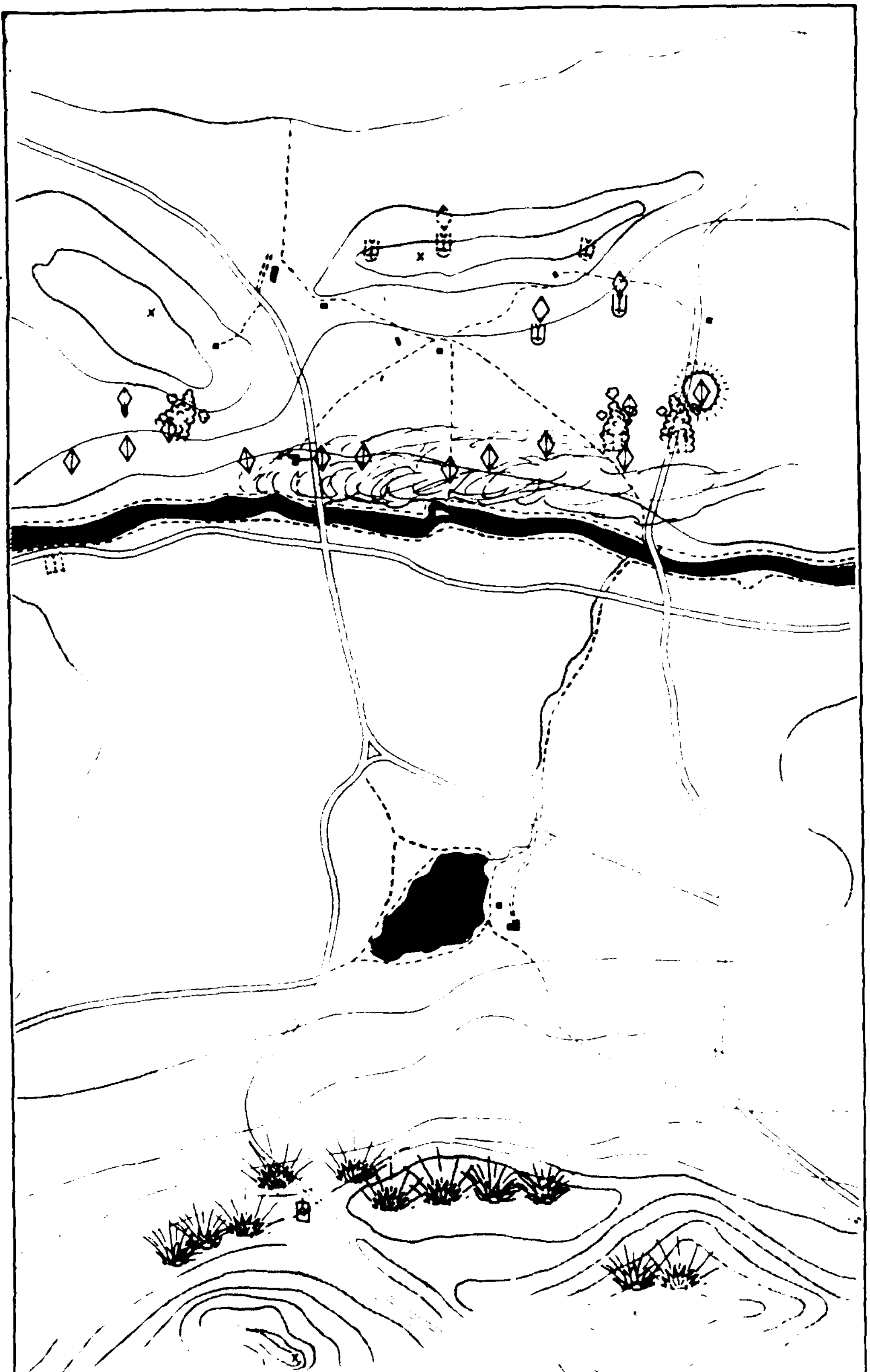
GO TO
THE NEXT
FRAME

Scenario 3 **Frame: 10**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	4 - 348	58. "ROGER MISSION WORKING - OUT."	
TOW platoon achieves a hit on a right flank BMP in Romeo BLUE's sector.	349		
		ON PLATOON NET	
	2 - 350	59. " 45 - 27. BINGO - OVER."	
			ON PLATOON NET
Platoon leader decides to engage by sections.	4 - 354		60. "THIS IS 45 - RED TARGETS AT MY COMMAND - OVER."
	2 - 356	61. "THIS IS 27 - WILCO - OUT."	
OPFOR ground mounted SAGGER launches an ATGM against a TOW position.	356		
		ON PLATOON NET	
	5 - 361	62. "ROMEO 45 - THIS IS BRAVO 4 GOLF 17 ON YOUR PUSH - OVER."	
			ON PLATOON NET
	2 - 363		63. "THIS IS 45 - OVER."

Frame: 10

SCALE:
¼=200m



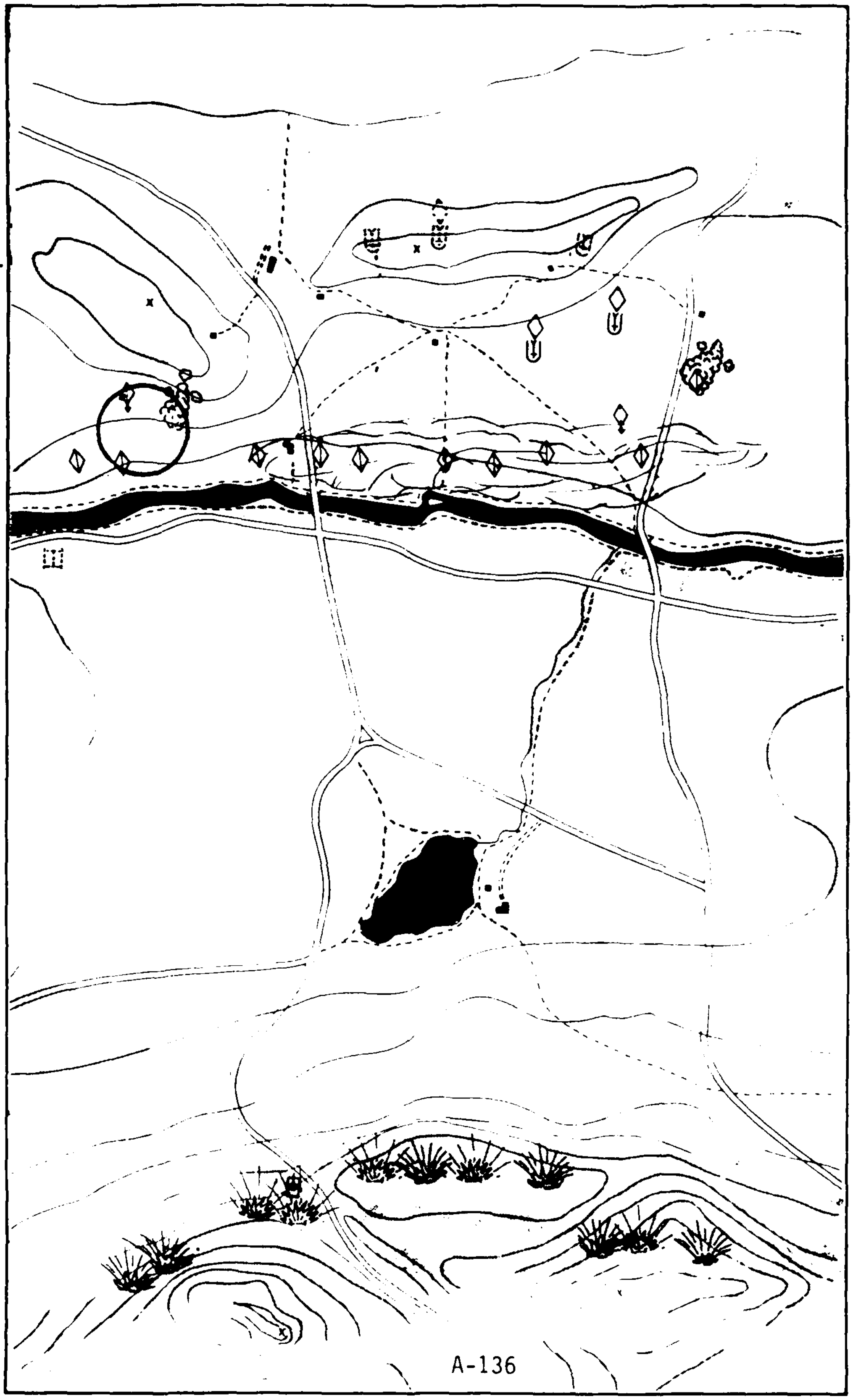
GO TO
THE NEXT
FRAME

Scenario 3 Frame: 11

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
OPFOR ATGM impacts at vacated TOW position.	370	ON PLATOON NET	
	10 - 373	64. "THIS IS GOLF 17 - RIGHT FLANK MIKE INDIA - DELTA ONE. BRAVO MIKE PAPAS VICINITY ZERO ZERO EIGHT CONSIDER IN SALLY - OVER."	
	3 - 376		ON PLATOON NET 65. PLATOON LEADER OBSERVES ZERO ZERO EIGHT (TC SIGHT). "THIS IS 45 - ROGER - OUT."
	4 - 380	66. "ROMEO 45 - THIS IS 36. BLUE BINGO - OVER."	
A TOW launches against a BRDM in BLUE sector.	380		
	10 - 382		67. "THIS IS 45 - I'VE REQUESTED CANDY OR ALPHA ALPHA FOUR ZERO ZERO FIVE TO OBSCURE ALPHA TANGO GOLF MIKE SUPPORT POSITIONS. CONTINUE TO USE TANGO INDIA SERRIA. PRIORITY BRAVO MIKE PAPAS IN CANDY - OVER."
	2 - 384	68. "THIS IS 36 - WILCO-OUT."	
Adjusting round on the way.	384	ON FIRE CONTROL NET	
	4 - 388	69. "ROMEO 45 - THIS IS CHARLIE 42. SHOT - OVER."	ON FIRE CONTROL NET
ROMEO BLUE engages two BMPs.	2 - 390		70. "SHOT - OUT."
	391	NON VOICE AUDIO Sound of firing tanks.	

Frame: 11

SCALE:
¾"= 200m



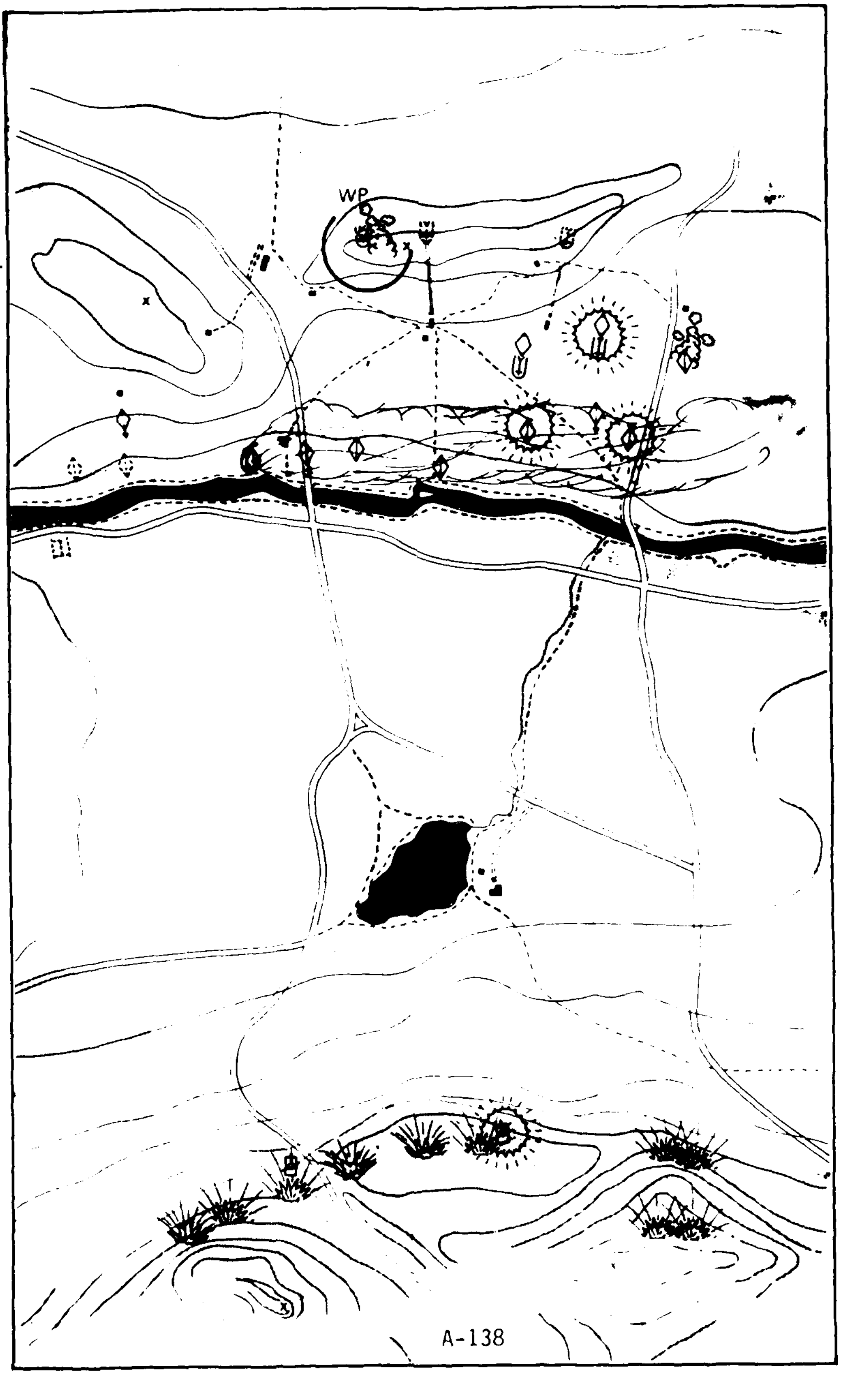
GO TO
THE NEXT
FRAME

Scenario 3 Frame: 12

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
ROMEO BLUE achieves hits on two BMPs and displaces to new firing positions.	392		
TOW platoon achieves a hit in Romeo BLUE's sector.	394		
	4 - 395		ON PLATOON NET 71. "ROMEO 27 - ROMEO 45. THREE PC (PAPA CHARLIE), VICINITY ZERO ZERO NINER. FRONTAL. FIRE"
	3 - 398	ON PLATOON NET 72. "THIS IS 27 - WILCO OUT."	
OPFOR SAGGERS launch ATGM against ROMEO BLUE.	399		
	3 - 402		ON INTERCOM 73. "GUNNER - HEP. MOVING PC (PAPA CHARLIE), LEFT."
	3 - 405	ON INTERCOM 74. LOADER: "UP." GUNNER: "IDENTIFIED."	
	2 - 407	DISPLAY Platoon leader observes: ● Adjusting smoke round impace. Range and deflection correct.	75. "FIRE AND ADJUST."
OPFOR indirect fire scores a direct hit on Tank 13.	408		

Frame: 12

SCALE: ¼ = 200m



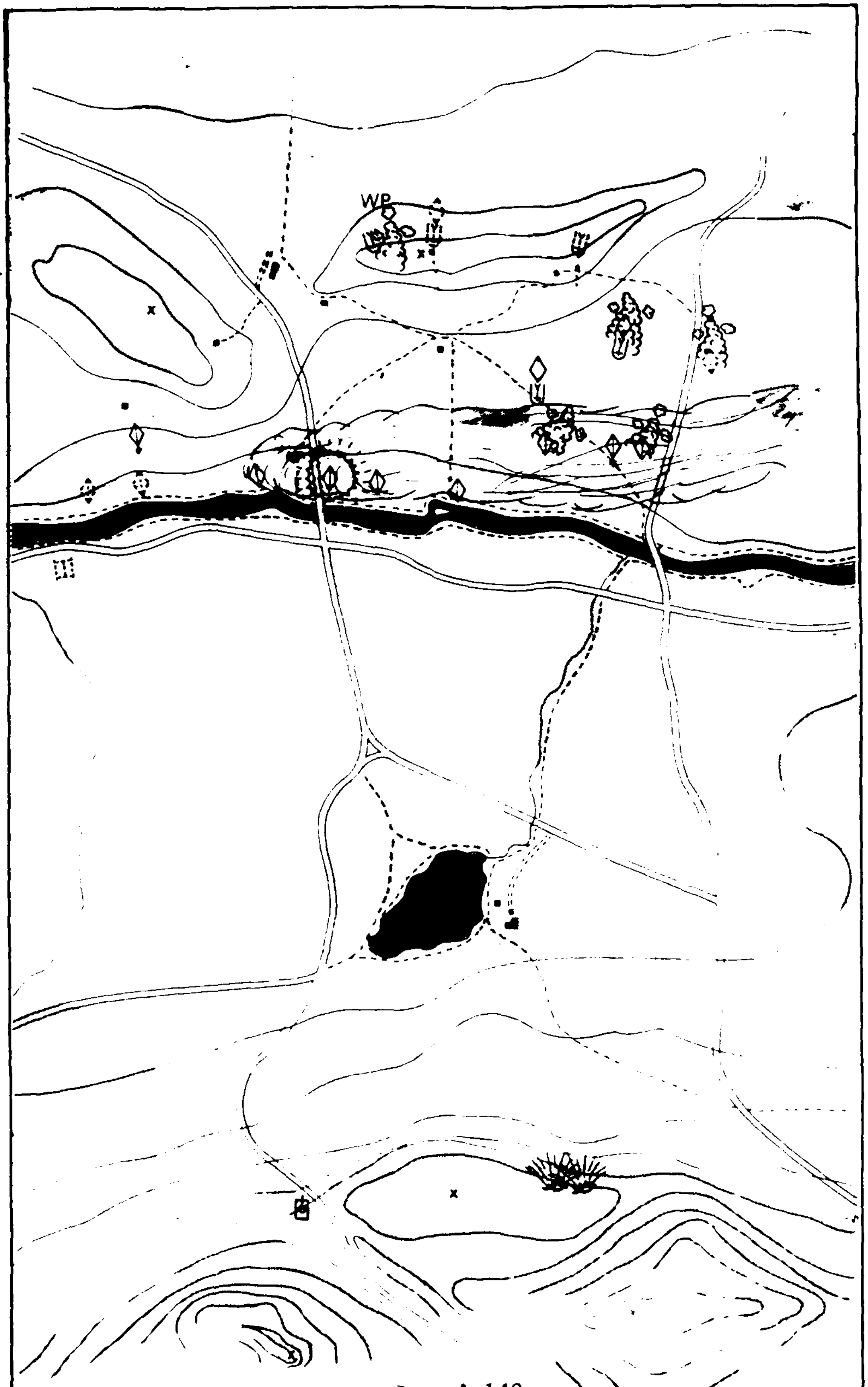
GO TO THE NEXT FRAME

Scenario 3 Frame: 13

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
OPFOR artillery stops.	409		
Tank 27 achieves a hit on a BMP and displaces to a new firing position.	409		
		NON VOICE AUDIO	
OPFOR ATGM impact at ROMEO BLUE's vacated firing position.	412	Sound of Tank 10 firing.	
			ON FIRE CONTROL NET
	7 - 414		75. "CHARLIE 42 THIS IS ROMEO 45. FIRE FOR EFFECT. BATTERY TWO. REQUEST CANDY - OVER."

Frame: 13

SCALE:
¼=200m



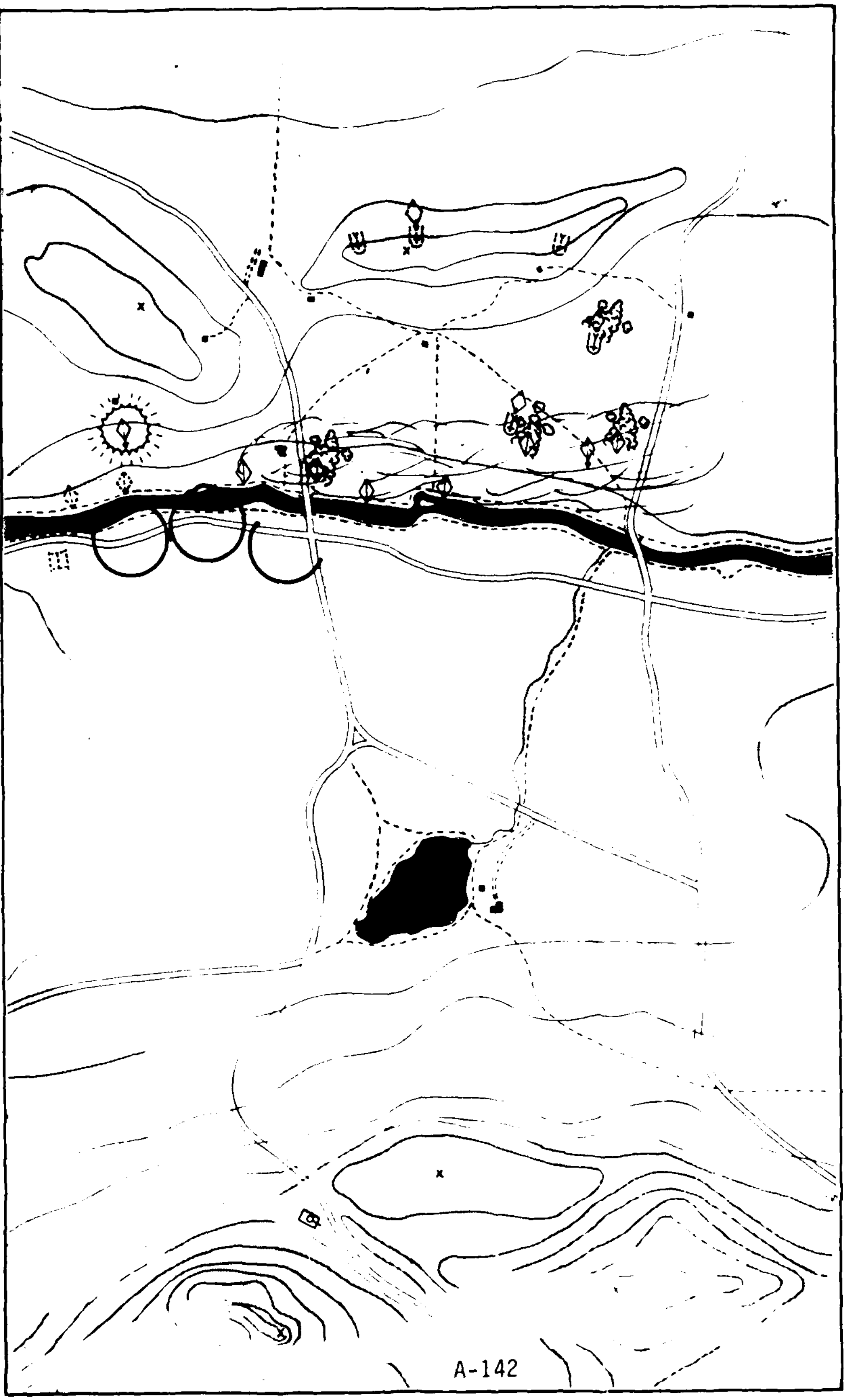
GO TO
THE NEXT
FRAME

Scenario 3 — Frame: 14

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		FIRE CONTROL NET	
Fire mission working.	6 - 420	76. "THIS IS CHARLIE 42 - FIRE FOR EFFECT. BATTERY TWO - CANDY. WAIT - OUT."	
Tank 10 achieves a hit on BMP at TRP 008.	417		
		ON INTERCOM	
		77. GUNNER - "TARGET CEASE FIRE."	
	3 - 420		ON INTERCOM
	2 - 422		78. "DRIVER - TALLY HO."
		ON PLATOON NET	
	7 - 429	79. "45 - THIS IS 36 - BINGO. MIKE INDIA ONE THREE DELTA ONE - TWO BRAVO MIKE PAPAS DESTROYED OVER."	
			ON PLATOON NET
	6 - 435		80. "THIS IS 45 - ROGER. PRIORITY TO BRAVO MIKE PAPAS IN CANDY. AT MY COMMAND OVER."
	3 - 438	81. "THIS IS 36 - WILCO - OUT."	

Frame: 14

SCALE:
¾=200m



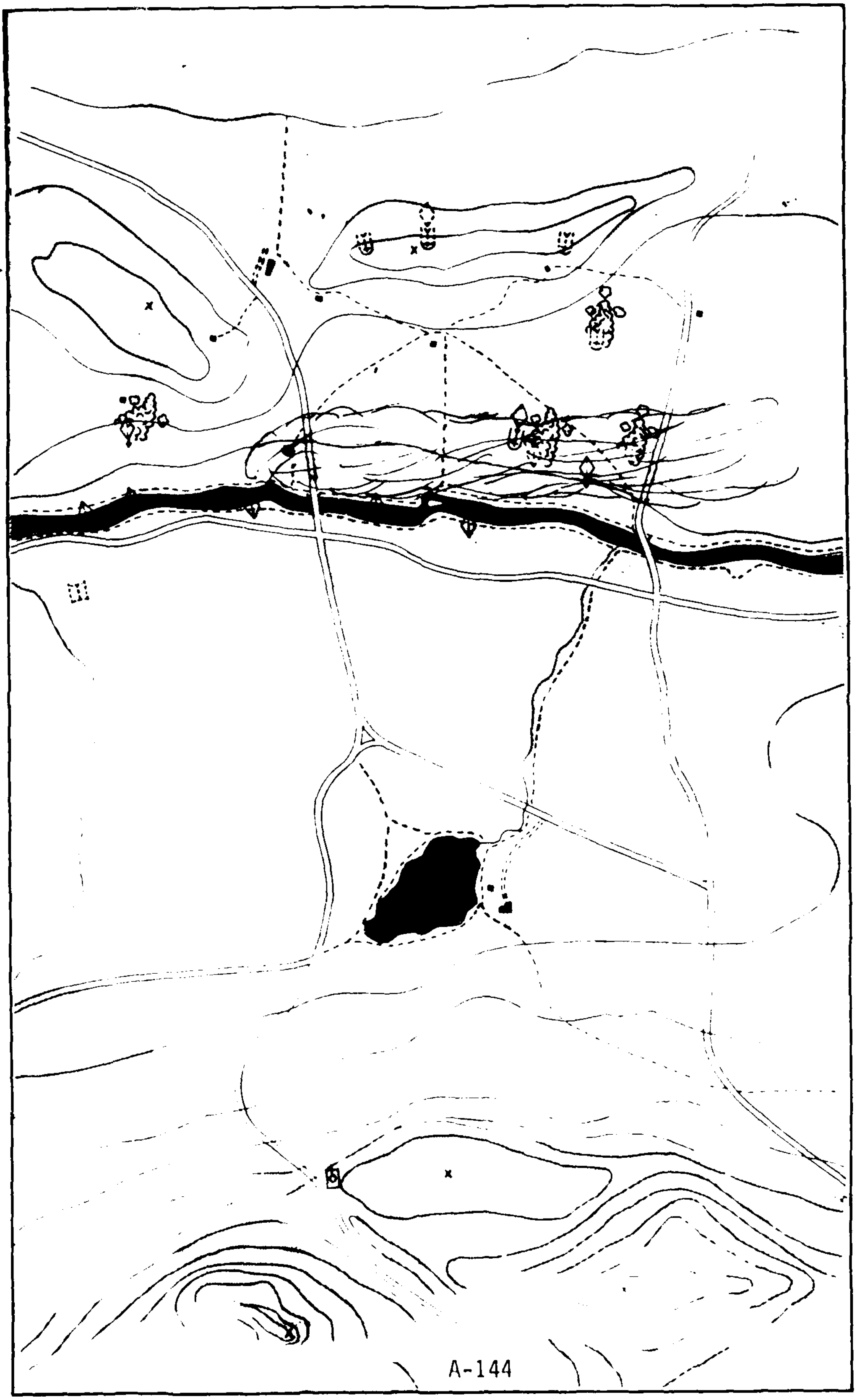
GO TO
THE NEXT
FRAME

Scenario 3 Frame: 15

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
Platoon leader's tank moves to new firing position. TOW platoon reaches new firing positions.	438		<u>ON PLATOON NET</u>
	3 - 441		82. "CHARLIE 5 PAPA 23 - THIS IS ROMEO 45. REPORT - OVER."
		<u>ON PLATOON NET</u>	
	10 - 451	83. "THIS IS 23. ALL BLUE BRAVO MIKE PAPAS IN CANDY. NO NEW VICTORS EAST OF ALPHA ALPHA FOUR ZERO ZERO FIVE. TWO BRAVO MIKE PAPAS CROSSING RIVER BETWEEN SALLY AND JANE. WILL ENGAGE - OVER."	
	3 - 454		84. "THIS IS 45 - ROGER - OUT."
Rounds on the way.	454		
		<u>ON FIRE CONTROL NET</u>	
Platoon leader's tank reaches primary position	454		
	4 - 455	85. "ROMEO 45 - THIS IS CHARLIE 42 - SHOT - OVER."	
			<u>ON FIRE CONTROL NET</u>
	2 - 457		86. "SHOT OUT."
TOW platoon launches against two BMPs crossing river.	459	<u>ON PLATOON NET</u>	
	3 - 462	87. ROMEO 45 - THIS IS 27. BINGO - OVER."	
			<u>ON PLATOON NET</u>
	7 - 469		88. "ROGER. BREAK. BRAVO 4 ROMEO - THIS IS ROMEO 45 MOVING PC (PAPA CHARLIE) BETWEEN TARGETS ALPHA AND CHARLIE ROMEO 27 - CROSS ROMEO 36 - FRONTAL AT MY COMMAND - OUT."

Frame: 15

SCALE:
¾ = 200m



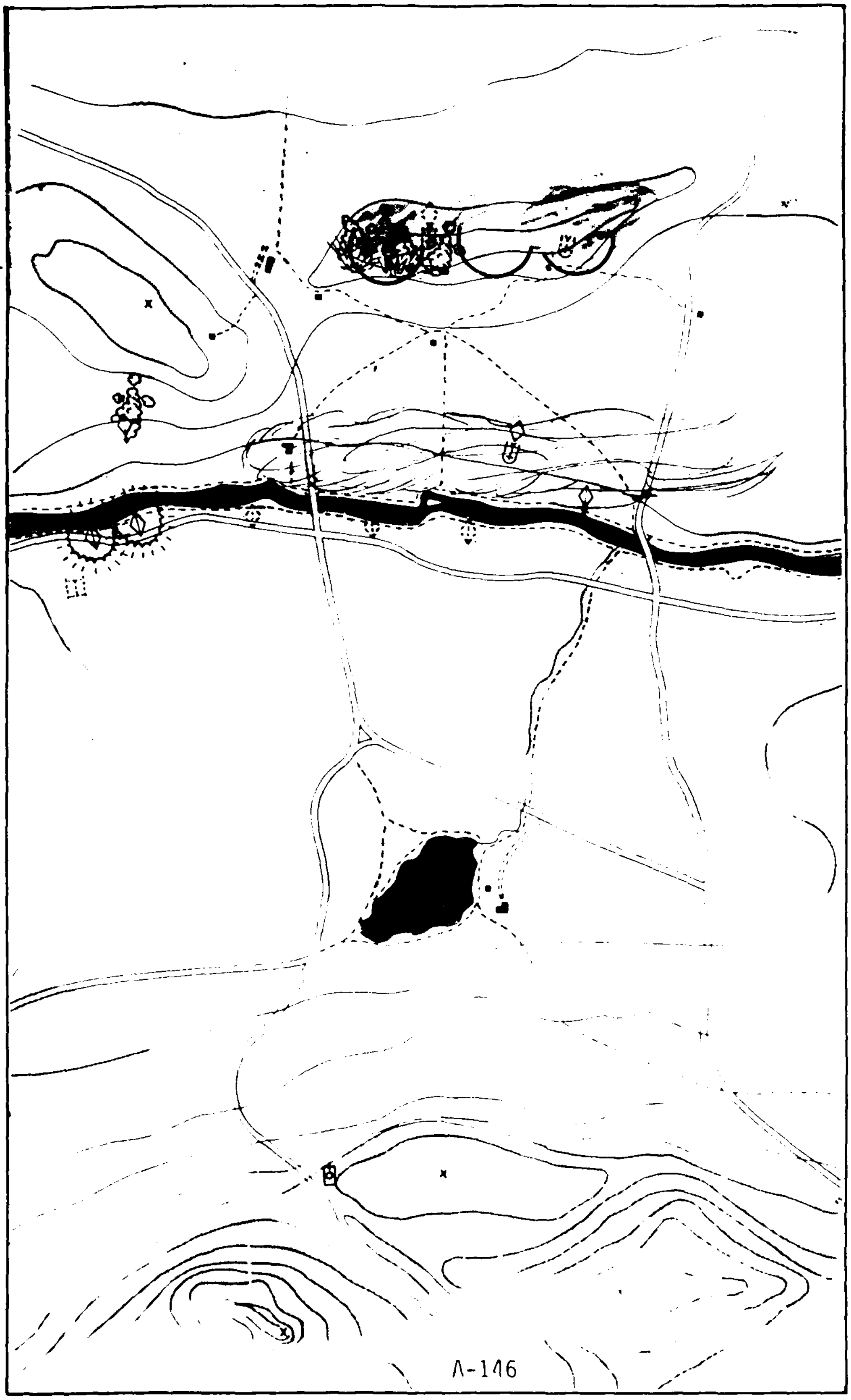
GO TO
THE NEXT
FRAME

Scenario 3 Frame: 16

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
TOW platoon achieves hits on two BMPS.	475		
		DISPLAY	
	8 - 477	First volley of smoke impacts at AA4005 and smoke carries south obscuring ooservation from that area.	89. PLATOON LEADER OBSERVES FIRST VOLLEY IMPACT AND SMOKE CARRYING SOUTH.
			ON PLATOON NET
	3 - 480		90. ROMEO 27 and 36 - THIS IS ROMEO 45 - FIRE - OUT."
		DISPLAY	
	7 - 487	Second volley of smoke impacts of AA4005.	
	7 - 487		91. PLATOON LEADER MONITORS ENGAGE-MENTS, OBSERVES EFFECT OF SMOKE.
		NON VOICE AUDIO	
	487	Sound of Tanks 27 and 36 firing.	
The T-80 and three BMPs on west side of river halt in woodline bordering river.	487		

Frame:16

SCALE:
¼"=200m



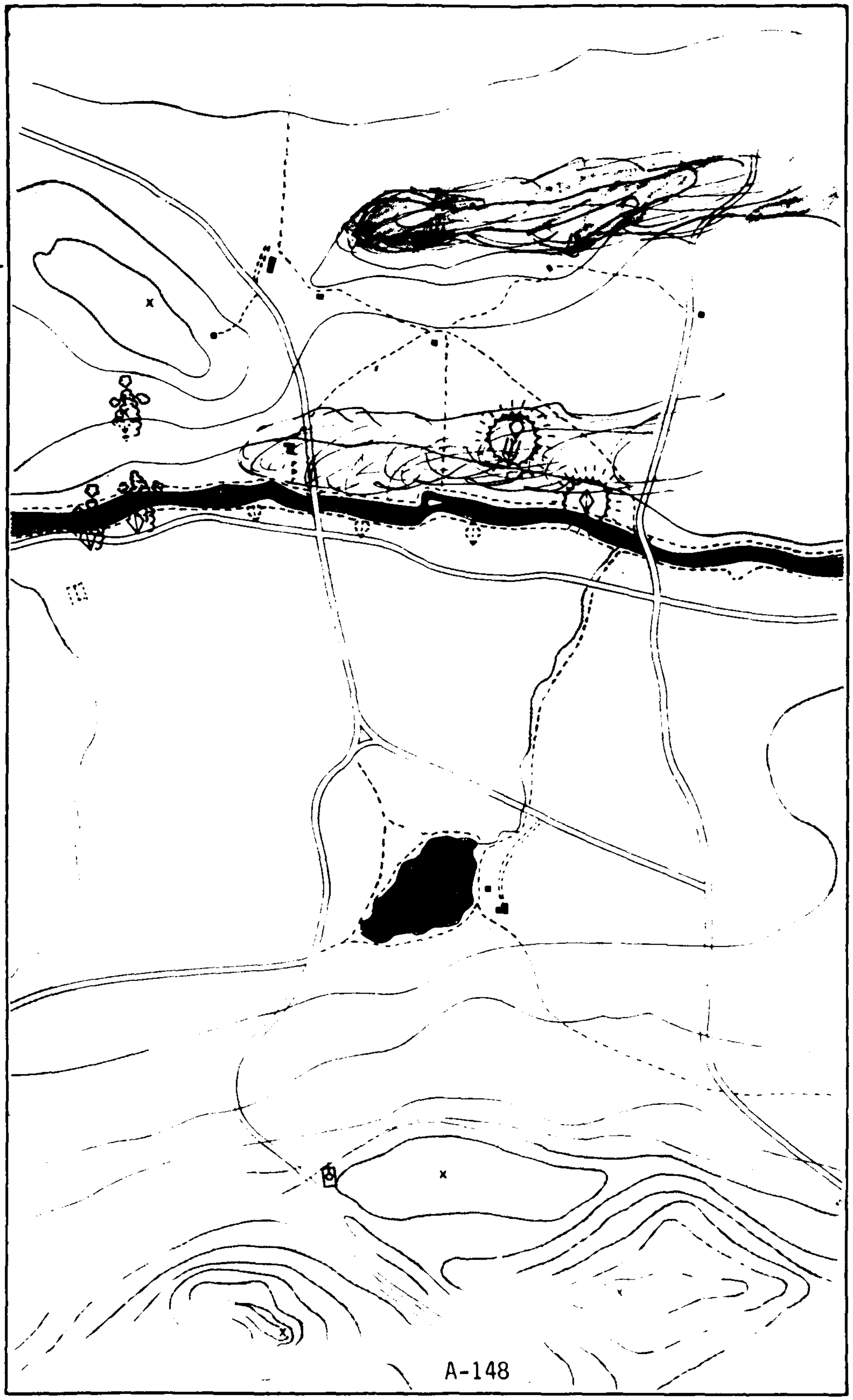
GO TO
THE NEXT
FRAME

Scenario 3 **Frame: 17**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
ROMEO 27 and 36 achieve first round hits.	490	ON PLATOON NET	
	10 - 500	93. "ROMEO 45 THIS IS 36. BRAVO MIKE PAPA AND BRAVO ROMEO DELTA MIKE DESTROYED. TALLY HO - OUT."	
	5 - 508	94. "ROMEO 45. THIS IS PAPA 23. TWO BRAVO MIKE PAPAS DESTROYED. TALLY HO - OUT."	
			ON FIRE CONTROL NET
	4 - 509	-	95. "CHARLIE 42 - THIS IS ROMEO 45 - OVER."
		ON FIRE CONTROL NET	
	3 - 512	96. "THIS IS 42 - OVER."	
	12 - 524		97. "THIS IS 45 - END OF MISSION GOOD OBSCURATION ON HILL 202. REQUEST YOU BE PREPARED TO REPEAT FIRE FOR EFFECT AT MY REQUEST - OVER."
	6 - 530	95. "THIS IS 42 - ROGER. TARGET DESIGNATION IS ALPHA ALPHA FOUR ZERO ONE SEVEN."	
	2 - 532		99. "ROGER - OUT."

Frame:17

SCALE:
¾=200m



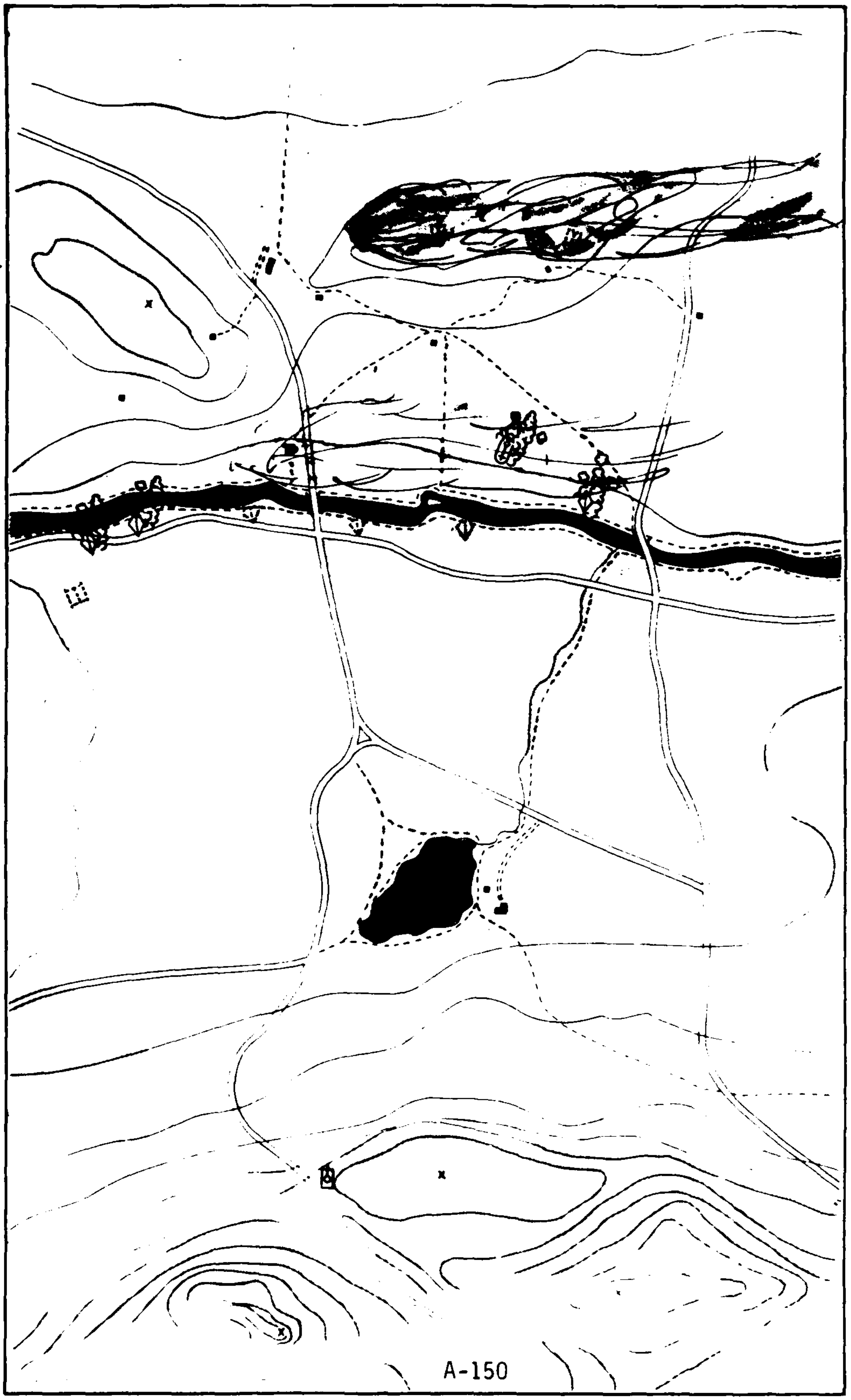
GO TO
THE NEXT
FRAME

Scenario 3 **Frame: 18**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON COMPANY NET
	3 - 535		100. "YANKEE 51 - THIS IS ROMEO 45. STAREP - OVER."
		ON COMPANY NET	
	3 - 533	101. "ROMEO 45 - THIS IS YANKEE 51 - OVER."	
	30 - 568		102. "THIS IS ROMEO 45. TIME NOW ____ LINE CHARLIE APPROXIMATELY THIRTEEN BRAVO MIKE PAPAS AND SIX TANGO EIGHTIES DESTROYED. CHARLIE PAPA TWO THREE REPORTS NO NEW TARGETS EAST OF ALPHA ALPHA FOUR ZERO ZERO FIVE. MAIN ASSAULT HAS BEEN STOPPED. THERE ARE SCATTERED SINGLE TARGETS IN SALLY; NEAR SIDE OF RIVER. WILL ADJUST CHARLIE 42. LINE DELTA - MIKE INDIA ONE THREE DELTA ONE LINE ECHO - SAME AS EARLIER REQUEST. OTHER LINES NO CHANGE. OVER."
	5 - 573	103. "THIS IS YANKEE 51 - ROGER - OUT."	

Frame:18

SCALE:
¾=200m



GO TO
THE NEXT
FRAME

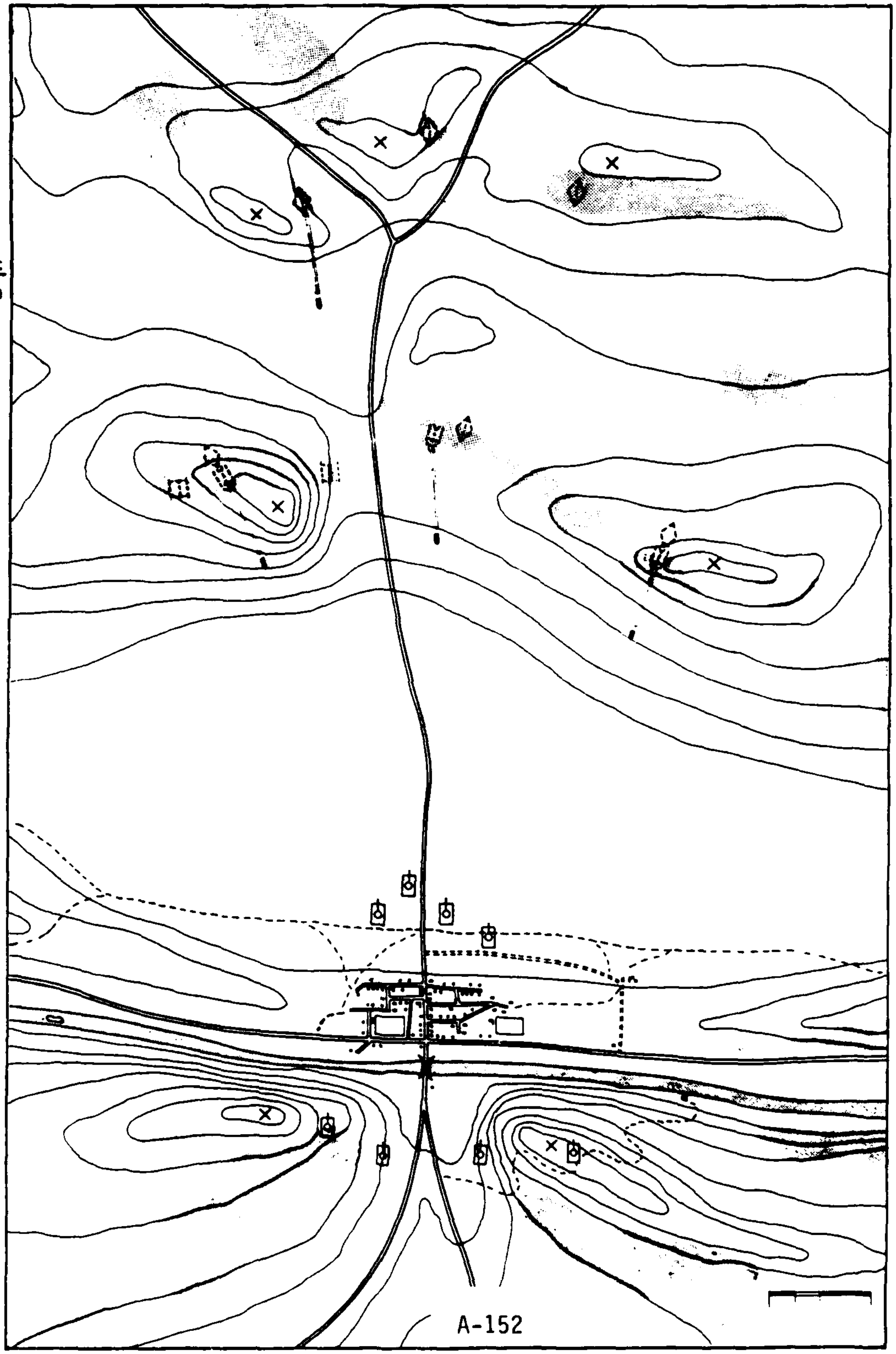
Scenario 4

Frame: 1

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
OPFOR fires ATGMs from high ground left (Hill 401) and right front (Hill 385).	00		1. PLATOON LEADER SEES ATGMS FIRED.
			<u>ON INTERCOM</u>
	5 - 5		2. "DRIVER - STOP. BACK UP. FAST."
			<u>ON PLATOON NET</u>
	10 - 15		3. "ROMEO - SAGGER. SAGGER. POP SMOKE. JINK TO COVER. BLUE RIGHT REAR. RED TO LEFT REAR - OUT."

Frame:1
4

SCALE:
¾= 400m



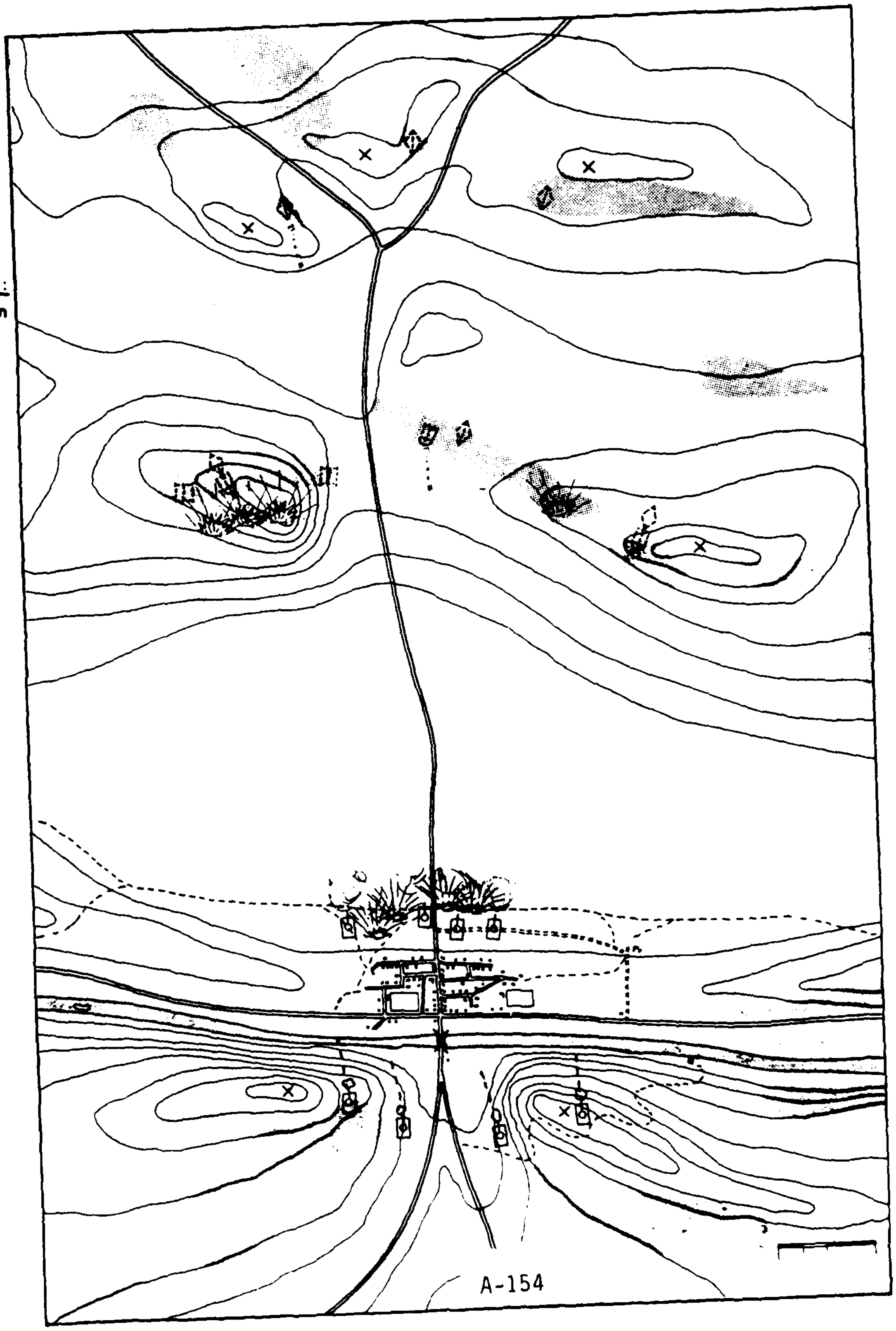
GO TO
THE NEXT
FRAME

Scenario 4 **Frame: 2**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
SAGGER gunners lose targets in smoke. ATGMs miss.	17	<u>NON VOICE AUDIO</u> Sound of ATGM impacting left and right of Tank 10.	
	7 -24		4. "DRIVER - LEFT." "DRIVER - RIGHT." "DRIVER - LEFT." "DRIVER - LEFT."

Frame: 2
4

SCALE:
¾= 400m



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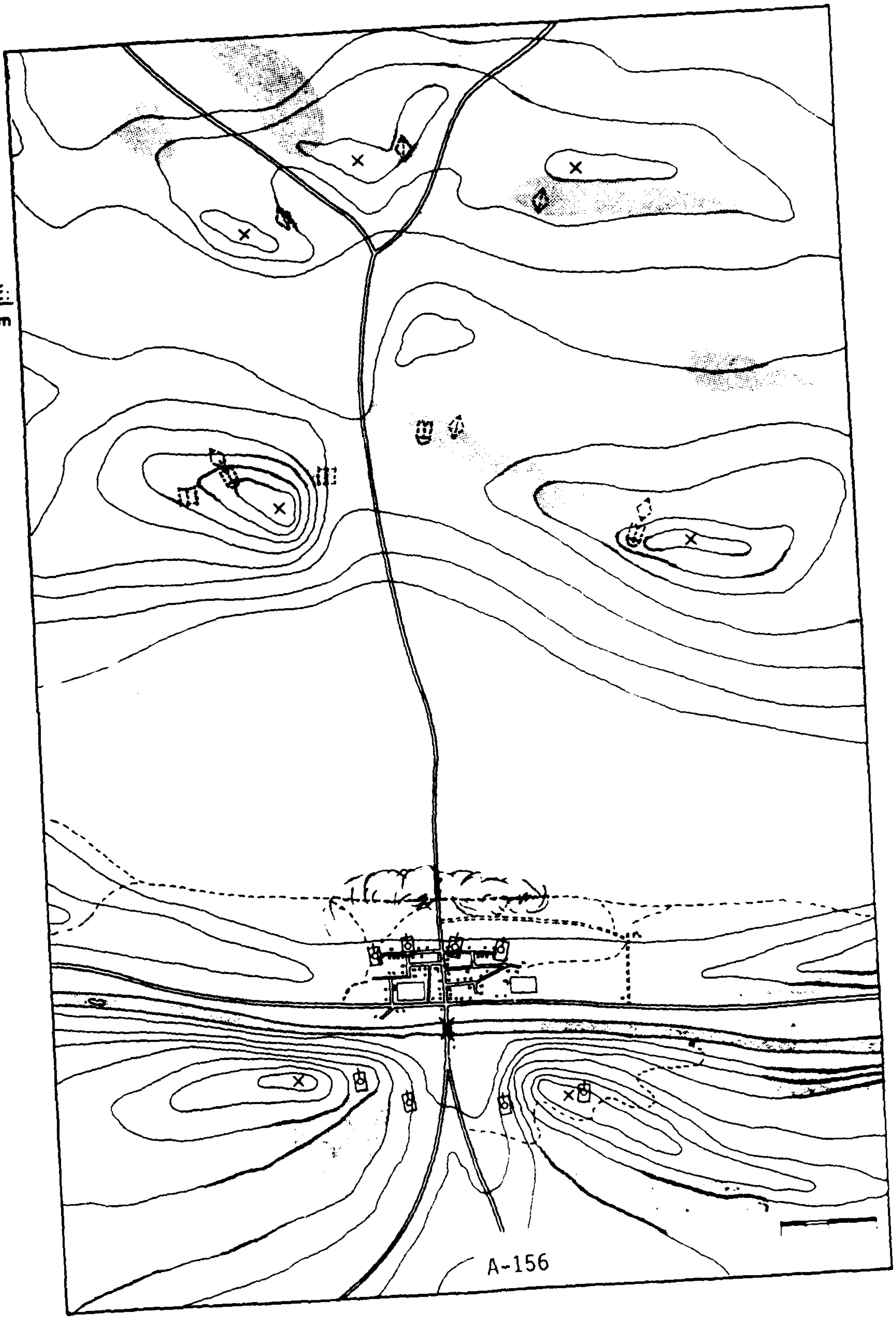
GO TO
THE NEXT
FRAME

Scenario 4 **Frame: 3**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	15 - 39		5. "DRIVER - STOP. PULL UP TO THAT WALL TO YOUR LEFT FRONT. DRIVER STOP. GUNNER - CAN YOU OBSERVE HIGH GROUND LEFT AND RIGHT OF THE ROAD?"
		<u>ON INTERCOM</u>	
	2 - 41	6. GUNNER - "ROGER".	
	4 - 45		7. "SEARCH THE HIGH GROUND ON THE LEFT."
			<u>ON PLATOON NET</u>
	5 - 50		8. "ROMEO - REPORT READY IN DEFILADE FIRING POSITION - OUT."
		<u>ON PLATOON NET</u>	
	5 - 55	9. "64 - READY - OUT." "36 - READY - OUT." "27 - READY - OUT."	
	10 - 65		10. "THIS IS 45 - CANNOT OBSERVE TARGETS AT THIS TIME. RED ENGAGE OBSERVED TARGETS LEFT OF ROAD. BLUE RIGHT OF ROAD."

Frame: 3
4

SCALE:
½= 400m



GO TO
THE NEXT
FRAME

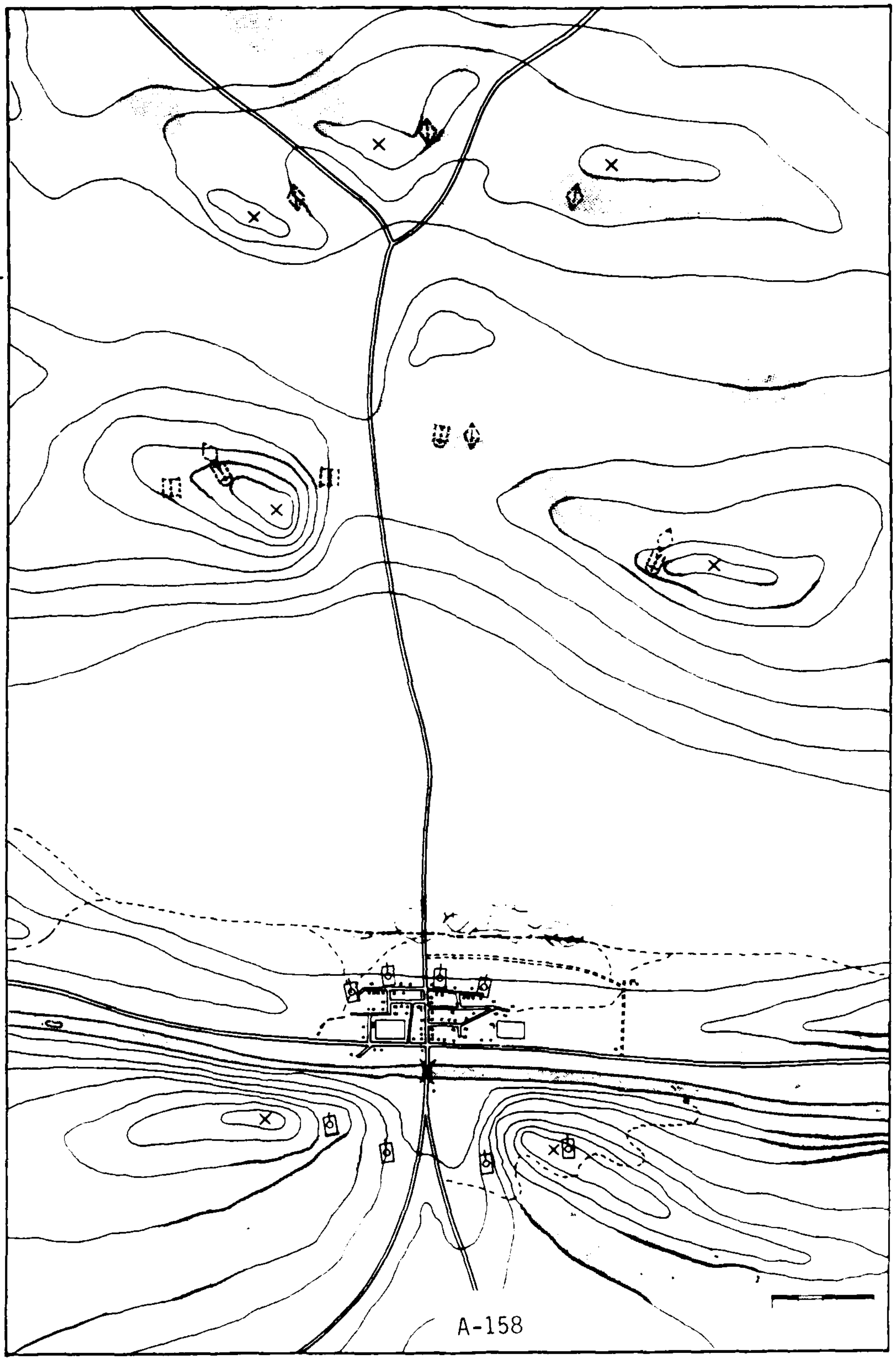
Scenario 4 **Frame: 4**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			<u>ON COMPANY NET</u>
	5 - 70		11. "BRAVO 4 GOLF 17 - THIS IS ROMEO 45 - OVER."
		<u>ON COMPANY NET</u>	
	3 - 75	12. "THIS IS GOLF 17 - OVER."	
			13. "THIS IS ROMEO 45 - DID YOU OBSERVE FIRE FROM HIGH GROUND TO OUR FRONT - OVER."
	10 - 83	14. "THIS IS GOLF 17 - ROGER. RETURNED FIRE. NO OBSERVABLE RESULTS. WILL ENGAGE OBSERVED TARGETS."	
			<u>ON COMPANY NET</u>
	4 - 87		15. "ALPHA 8 CHARLIE 42 - THIS IS ROMEO 45 - OVER."
		<u>ON COMPANY NET</u>	
	3 - 90	16. "THIS IS CHARLIE 42 - OVER."	
	4 - 91		17. "THIS IS ROMEO 45 - WILL MEET YOU ON YOUR PUSH OUT."

Frame: 4

4

SCALE:
¾= 400m



A-158

GO TO THE NEXT FRAME

Scenario 4 Frame: 5

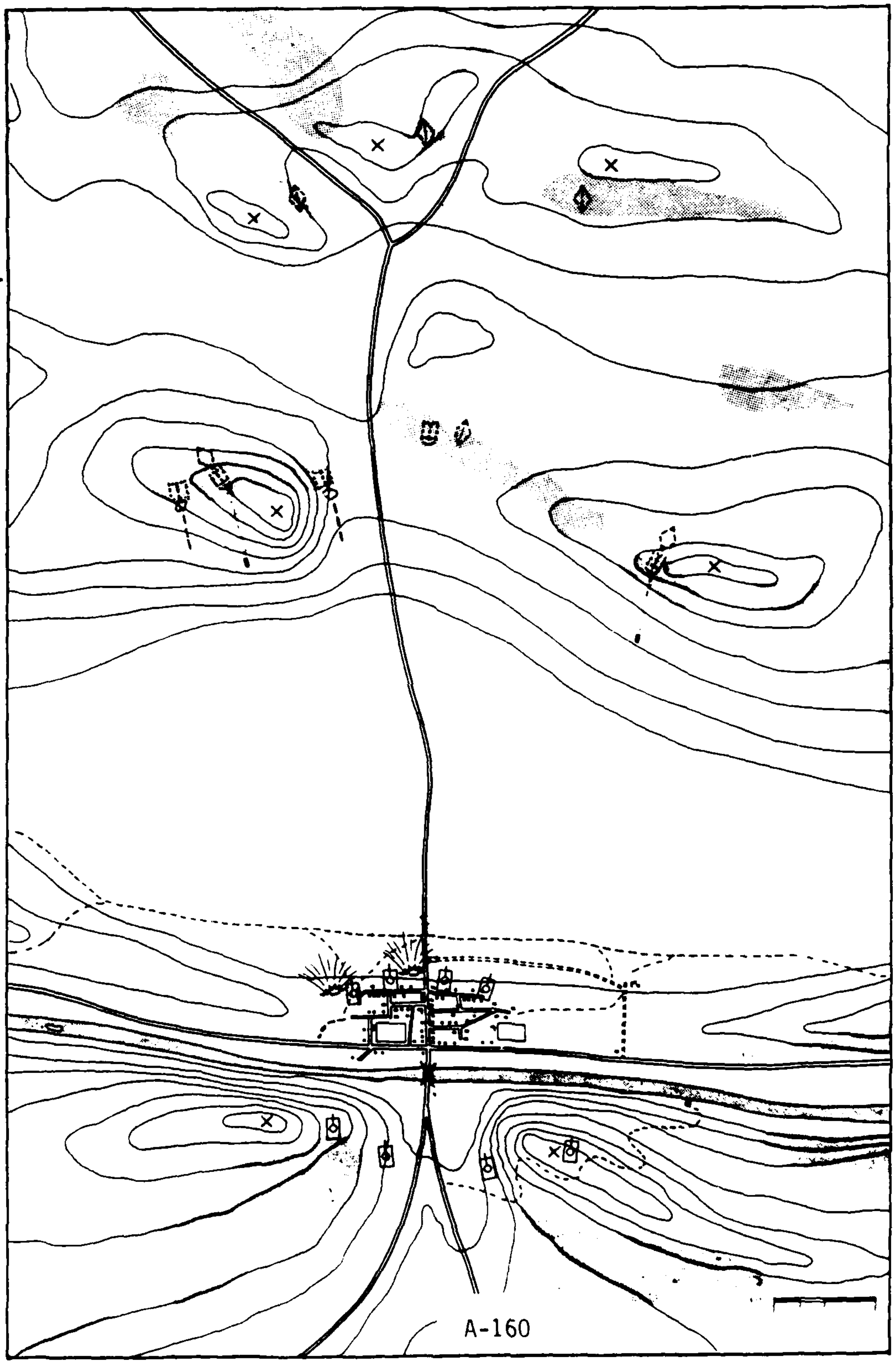
CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON FIRE CONTROL NET
	3 - 97		18. "CHARLIE 42 - THIS IS BRAVO 45 - WAIT - OUT."
Engagement of identified threatening target becomes a priority mission.	3 -100		
		DISPLAY	
		Platoon leader observes: • T-80 firing from high ground near road. • Round impacting in house on South side of road.	
T-80 aquires M1 target (tank 10) and fires. First round misses.	97-100		
		NON VOICE AUDIO	
	100	Sound of impacting tank round.	
T-80 acquires M1 target (tank 27) and fires. First round misses.	4 -103		19. PLATOON LEADER SLEWS TURRET TO ALIGN SIGHTS/TUBE ON TARGET.
			ON INTERCOM
	3 -106		20. "GUNNER - SABOT. TANK."
Overwatch section (RED) positioned North of road observes T-80 engage ROMEO 27 and begins target acquisition.	3 -106		
OPFOR ATGM launch against overwatch platoon (BRAVO 4 GOLF 17).			

Frame: 5

4

SCALE:

¾= 400m



GO TO THE NEXT FRAME

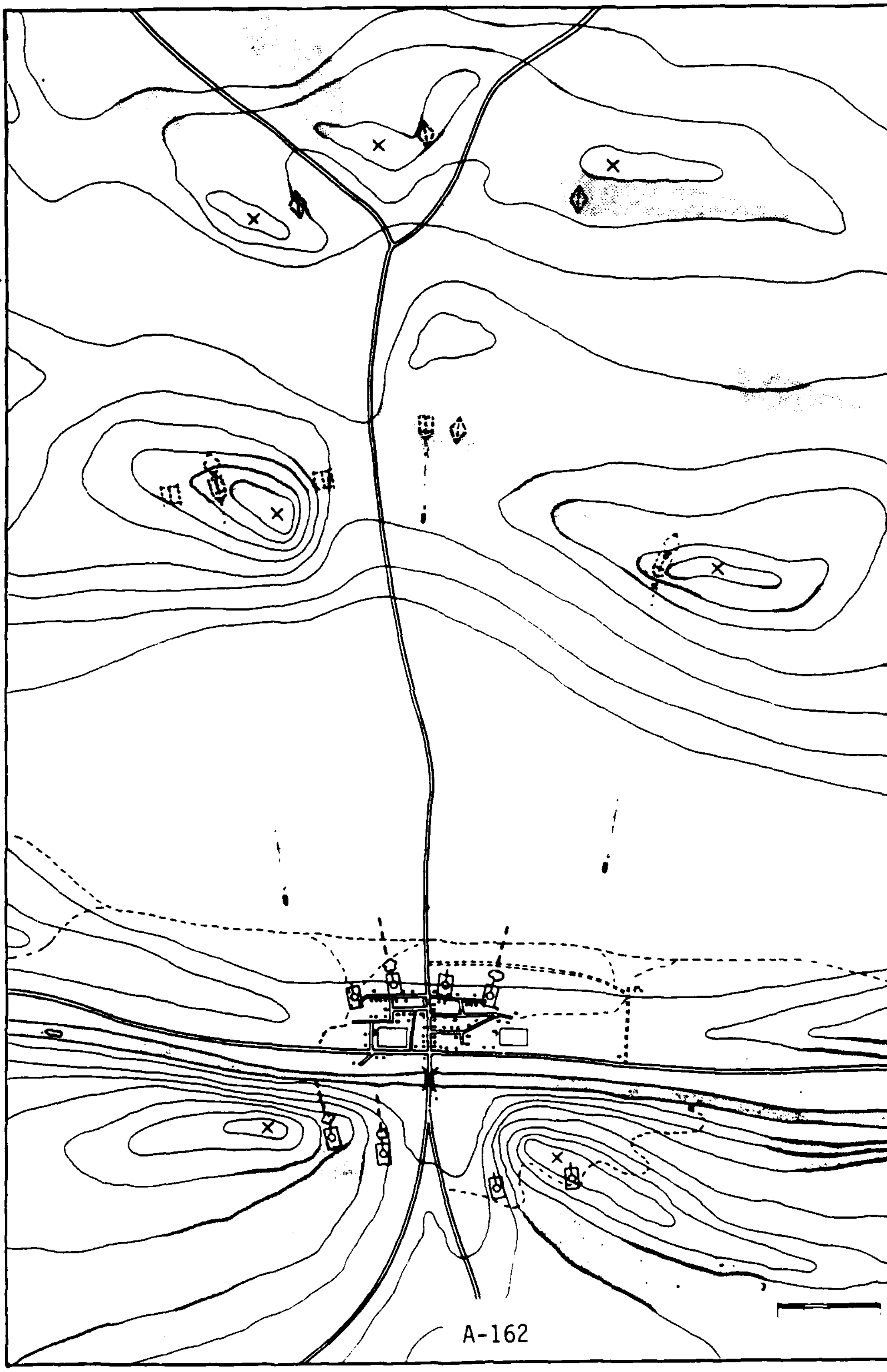
Scenario 4 Frame: 6

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		ON INTERCOM	
	3 -109	21. LOADER : "UP". GUNNER : "IDENTIFIED".	
	1 -110		22. "FIRE."
		NON VOICE AUDIO	
		Sound of tank 10 firing.	
BRAVO 4 GOLF 17's RED section engages T-80 on left side of Hill 401.	112		
ROMEO BLUE engages firing SAGGER vicinity Hill 385.	112		
Overwatch section (BLUE) positioned South of the road begins to pull back into HIDE position.	112		

Frame: 6

4

SCALE:
¼ = 400m



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FRAME

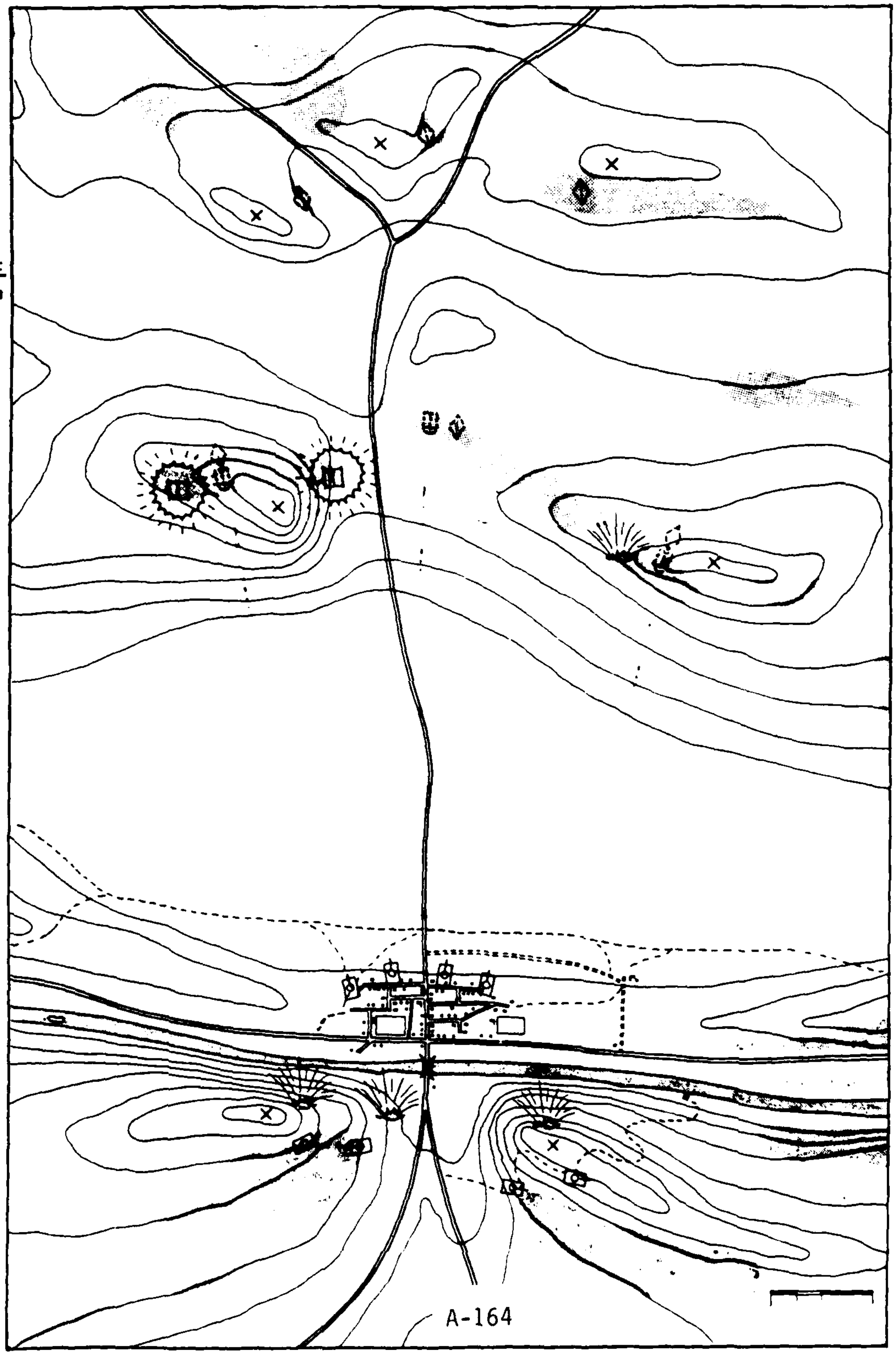
Scenario 4 Frame: 7

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	113	Platoon leader observes: • A direct hit.	
GOLF 17's BLUE section scores a hit on the targeted T-80.	115		
			. ON INTERCOM
	3 -116		22. "TARGET. CEASE FIRE. GUNNER - CONTINUE TO SEARCH."
OPFOR ATGM(2) impact.	122		
		ON PLATOON NET	
Overwatch platoon moves to new firing positions.	7 -123	23. "ROMEO 45 - THIS IS GOLF ON YOUR PUSH. ONE TANGO EIGHTY DESTROYED HILL 401. TALLY HO. WILL REPORT BINGO - OUT."	
OPFOR ATGM(1) impacts.	126		
	15 -141		24. PLATOON LEADER PLOTS A FIRE MISSION ON HILL 401.
			ON FIRE CONTROL NET
	5 -146		25. "ALPHA 8 CHARLIE 42 - THIS IS ROMEO 45 - OVER."
		ON FIRE CONTROL NET	
	5 -149	26. "THIS IS CHARLIE 42 - OVER."	
	5 -154		27. "THIS IS ROMEO 45 - ADJUST FIRE. SHIFT ECHO TWO FIVE - OVER."
	4 -158	28. "ADJUST FIRE - SHIFT ECHO TWO FIVE - OVER."	

Frame: 7

4

SCALE:
¾ = 400m



GO TO THE NEXT FRAME

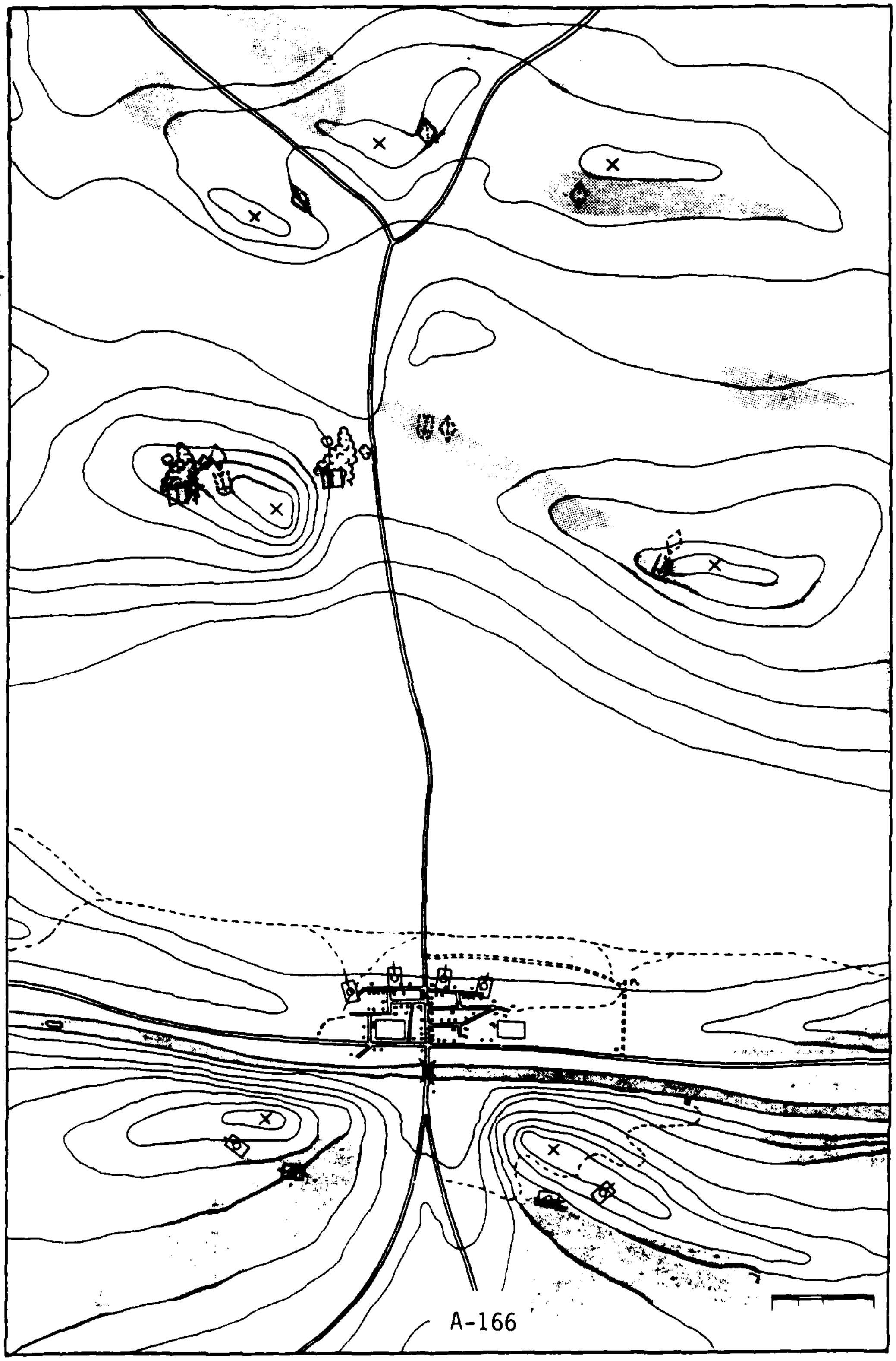
Scenario 4 **Frame: 8**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	5 -163		28. "DIRECTION ONE FOUR HUNDRED. LEFT ONE HUNDRED. ADD TWO HUNDRED - OVER."
	5 -168	29. "DIRECTION ONE FOUR HUNDRED. LEFT ONE HUNDRED. ADD TWO HUNDRED - OVER."	
	5 - 173		30. "TANGOS AND ALPHA TANGO GOLF MIKES IN WOODS ON HILL - OVER."
	10 -183	31. TANGOS AND ALPHA ALPHA TANGO GOLF MIKES IN WOODS ON HILL. AUTHENTICATE MIKE DELTA - OVER."	
	4 -187		32. "I AUTHENTICATE XRAY - OVER."
	4 -191	33. "ROGER - MISSION WORKING - OUT."	
Fire mission working	75 -268		
			ON COMPANY NET
	5 -196		34. "YANKEE 51 - THIS IS ROMEO 45. SPOTREP - OVER."
		ON COMPANY NET	
	3 -202	35. "THIS IS YANKEE 51 - OVER."	

Frame: 8

4

SCALE:
¾= 400m



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THE NEXT
FRAME

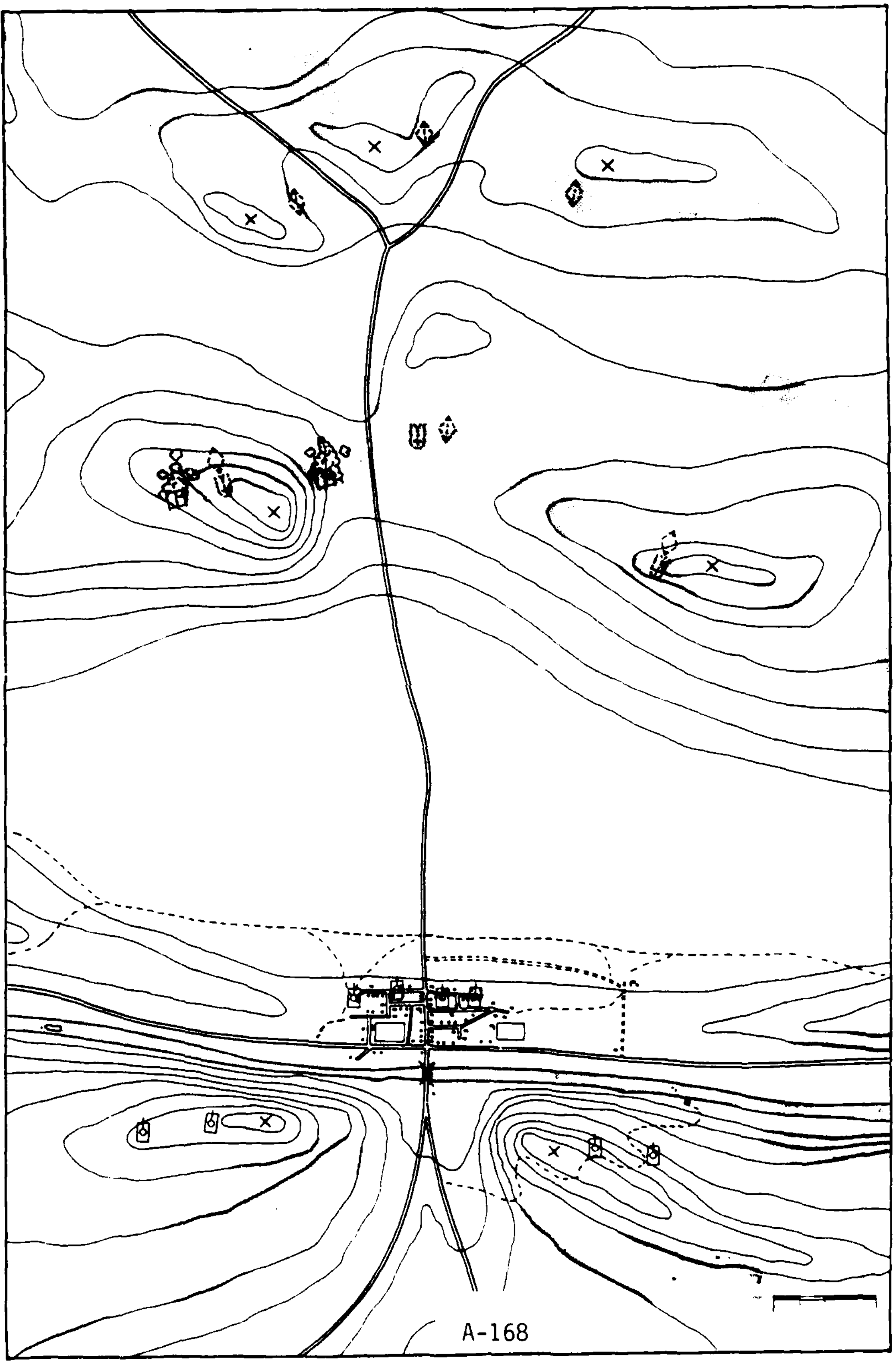
Scenario 4 Frame: 9

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
	40 -242		36. THIS IS ROMEO 45 - HAVE RECEIVED" ALPHA TANGO GOLF MIKE FIRE FROM HIGH GROUND TO MY FRONT. NORTH AND SOUTH OF BLACK TOP. HAVE RECEIVED TANGO FIRE FROM NORTH OF BLACK TOP. ENGAGED AND DESTROYED ONE TANGO. GOLF 17 SUPPORTING FROM OVERWATCH HAS DESTROYED ONE TANGO. AM EMPLOYING CHARLIE 42 ON HILL FOUR ZERO ONE. COVER AND CONCEALMENT BETWEEN MY POSITION AND ENEMY POSITION IS VERY POOR - OVER."
	5 -247	37. "THIS IS YANKEE 51 - ROGER. WAIT - OUT."	
		<u>ON PLATOON NET</u>	
	5 -252	38. "ROMEO 45 - THIS IS GOLF 17. BINGO - OUT."	
	253-265	No Activity.	
CHARLIE 42 fires adjusting round.	266		
		<u>ON FIRE CONTROL NET</u>	
	5 - 271	39. "ROMEO 45 - THIS IS CHARLIE 42. SHOT - OVER."	
			<u>ON FIRE CONTROL NET</u>
	3 -271		40. "SHOT OUT."

Frame: 9

4

SCALE:
¾= 400m



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FRAME

Scenario 4 **Frame: 10**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	5 -280	Platoon leader observes: • Round doubtful - over.	
			ON FIRE CONTROL NET
	5 -285		41. "CHARLIE 42 - 45. NONE. DROP TWO HUNDRED - OVER."
		ON FIRE CONTROL NET	
	3 -288	42. "DROP TWO HUNDRED OUT."	
Mission working.	30 -318		
	3 -321	43. "ROMEO 45 - SHOT - OVER."	
	2 -323		44. "SHOT OUT."
Round on the way.	15 -338		

Frame: 10

4

SCALE:
¼" 400m

GO TO
THE NEXT
FRAME

A-170

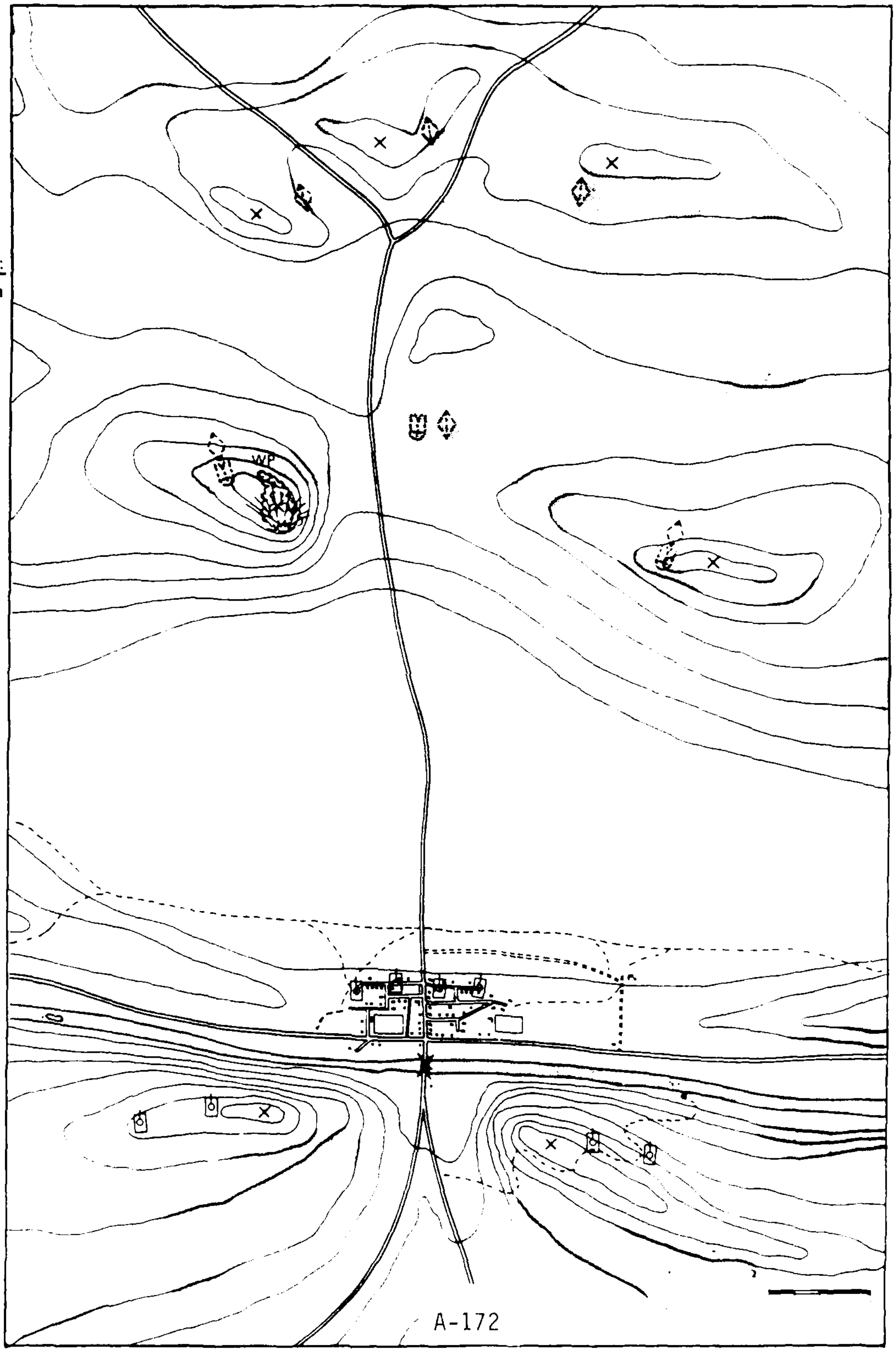
Scenario 4 Frame: 11

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
		Platoon leader observes: • Round on line - Short 50 meters.	
			ON FIRE CONTROL NET
	6 -344		45. "CHARLIE 42 - THIS IS 45. ADD FIVE ZERO. FIRE FOR EFFECT. BATTERY TWO - OVER."
		ON FIRE CONTROL NET	
	5-349	46. "ADD FIVE ZERO. FIRE FOR EFFECT. BATTERY TWO - OUT."	
Mission working.	29 -378		
Mission fired.	379		
	3 -382	47. "ROMEO 45 - SHOT - OVER."	
	2 -384		48. "ROGER - SHOT - OUT."

Frame: 11

4

SCALE:
¾= 400m



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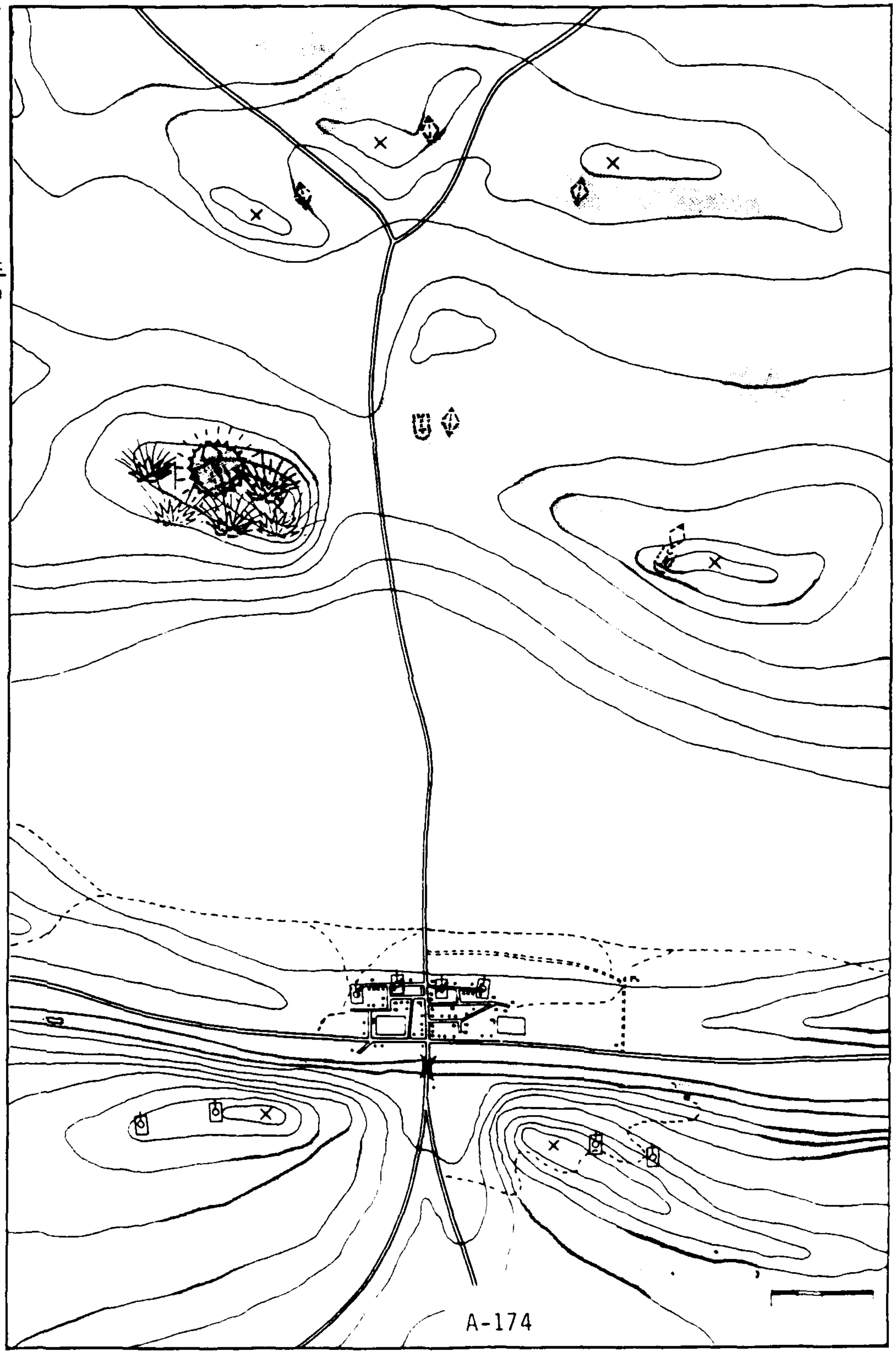
FRAME

Scenario 4 **Frame: 12**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		DISPLAY	
	30 -414	Platoon leader observes: • Two volleys of 155 impact on Hill 401.	
			ON FIRE CONTROL NET
	10 -424		40. "CHARLIE 47 - THIS IS 45. END OF MISSION - REQUEST YOU BE PREPARED TO REPEAT FIRE FOR EFFECT LATER - OVER."
		ON FIRE CONTROL NET	
	8-432	50. "THIS IS 42 - ROGER. TARGET DESIGNATION IS ALPHA ALPHA FOUR ZERO ZERO FIVE - OVER."	
	8 -440		51. "THIS IS 45 - ROGER. TARGET DESIGNATION ALPHA ALPHA FOUR ZERO ZERO FIVE - OUT."

Frame: 12

SCALE:
¼" = 400m



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FRAME

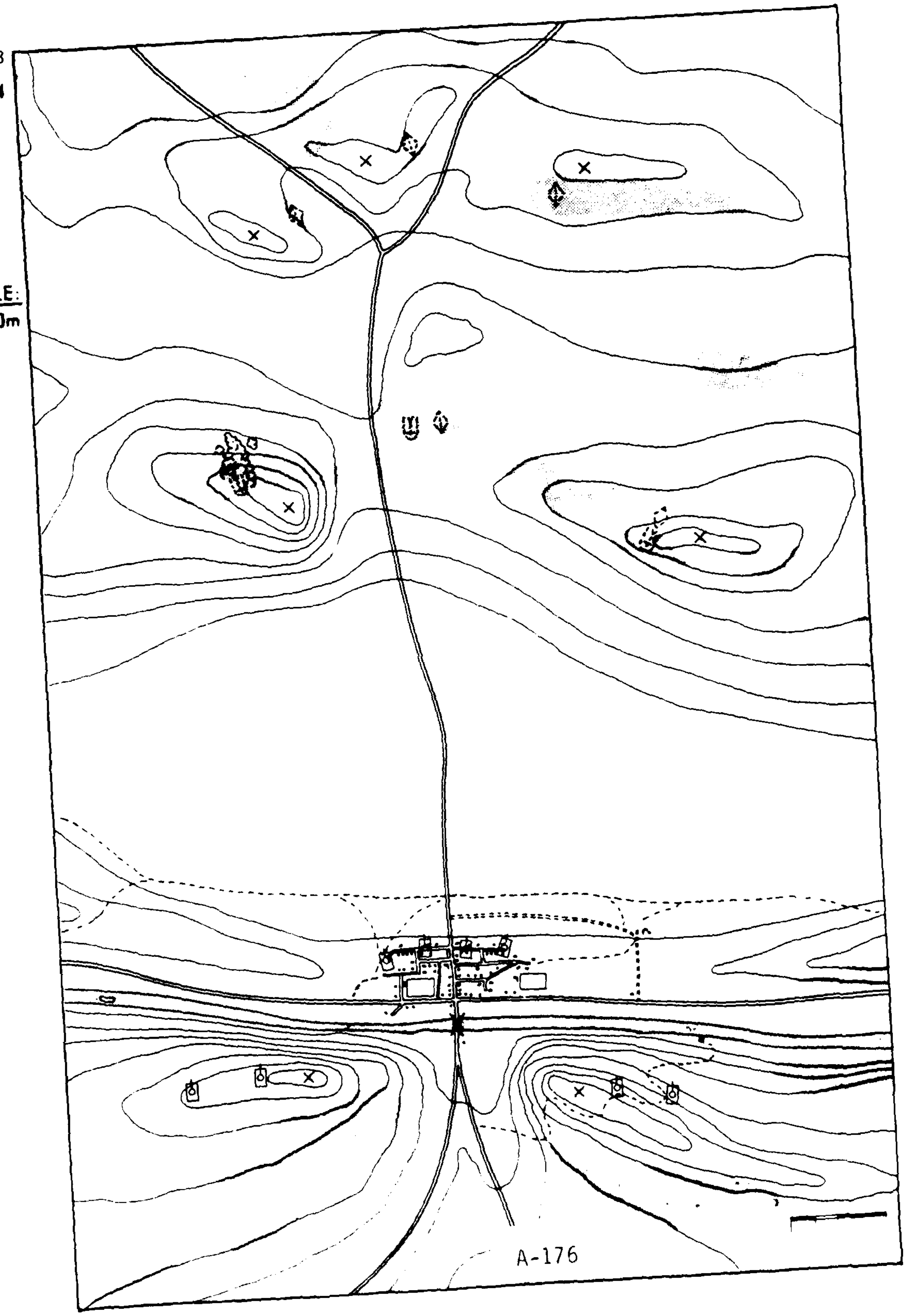
Scenario 4 **Frame: 13**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
		ON COMPANY NET	
	5 - 445	52. "ROMEO 45 - THIS IS YANKEE 51 - OVER."	
			ON COMPANY NET
	3 - 448		53. "THIS IS ROMEO 45 - OVER."
	30 - 478	54. "THIS IS YANKEE 51 - ECHO SIX MIKE TWO ONE WILL EMPLOY CHARLIE SIX ZULU TWO THREE TO ATTACK HILLS FOUR ZERO ONE AND THREE EIGHT FIVE FROM NORTH OR SOUTH FLANK. RECON BEING CONDUCTED NOW. WILL INFORM YOU OF PLAN WHEN COMPLETED. YOU AND GOLF ONE SEVEN CONTINUE TO ENGAGE OBSERVED TARGETS. REQUEST CHARLIE FOUR TWO TO PUT PERIODIC FIRE ON BOTH HILLS. WILL NOTIFY YOU WHEN TO TERMINATE OVER."	
			55. "THIS IS ROMEO 45 - WILCO - OUT."
		ON COMPANY NET	
	5 - 483	56. "CHARLIE 42 AND GOLF 17 - DID YOU MONITOR? OVER."	
	5 - 488	"THIS IS CHARLIE 42 - ROGER. OUT."	
	5 - 493	"THIS IS GOLF 17. ROGER. OUT."	

Frame: 13

4

SCALE:
¾= 400m



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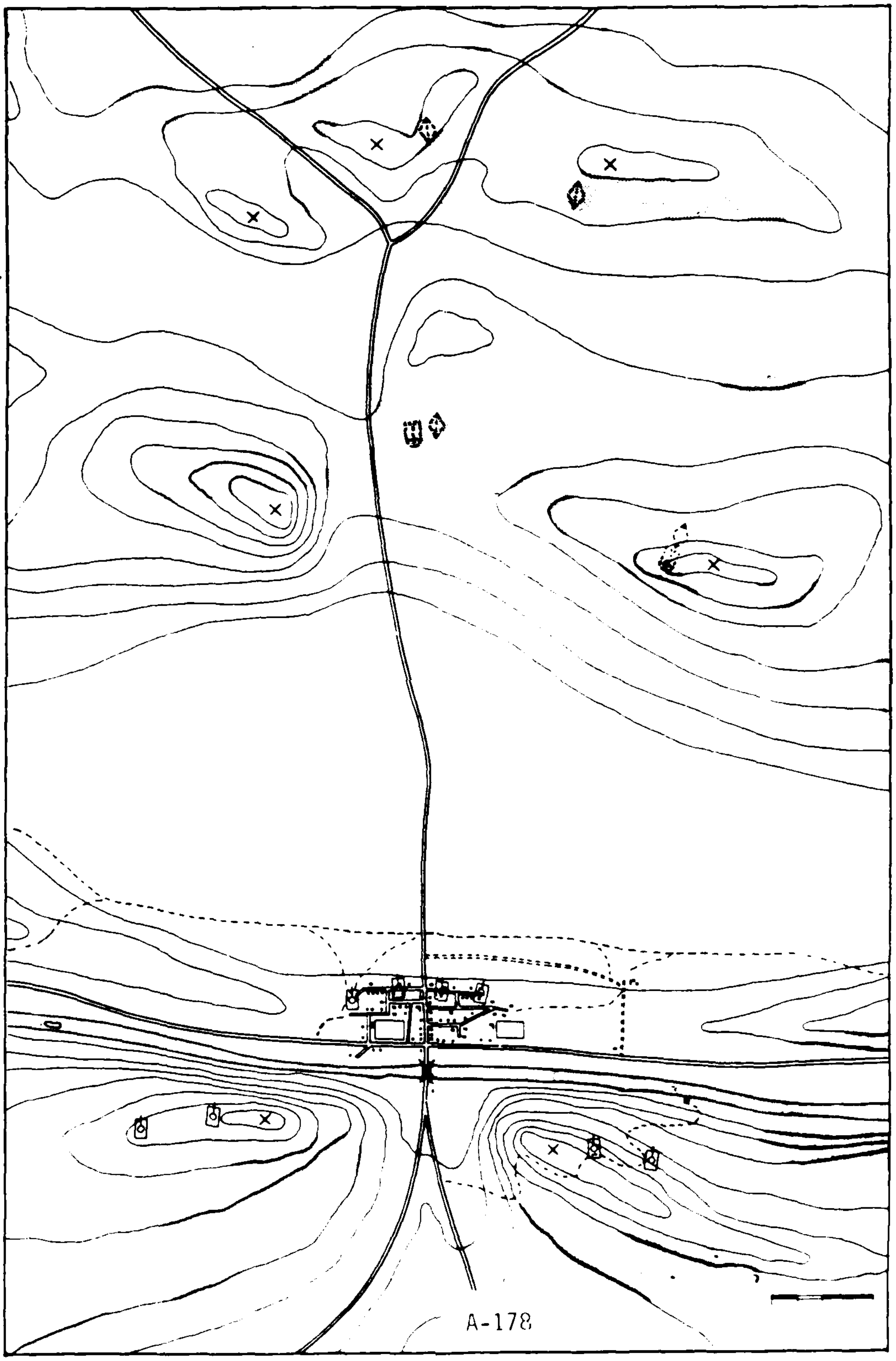
FRAME

Scenario 4 **Frame: 14**

CONDITION	TIME (SEC)	VISUAL/AUDIO CUE	STUDENT RESPONSE
			ON FIRE CONTROL NET
	6 -499		57. "CHARLIE 42 - THIS IS ROMEO 45. IMMEDIATE SUPPRESSION ALPHA ALPHA ZERO ZERO ONE - OVER."
		ON FIRE CONTROL NET	
	6 -485	58. "THIS IS CHARLIE 42. IMMEDIATE SUPPRESSION ALPHA ALPHA ZERO ZERO ONE. WAIT - OUT."	
			ON PLATOON NET
	20 -505		59. ROMEO - THIS IS 45 - HIGHER WILL ATTACK THOSE HILLS WITH ANOTHER UNIT FROM FLANK. RED CONTINUE TO ENGAGE OBSERVED TARGETS ON LEFT. BLUE ON RIGHT. I WILL USE INDIRECT. GOLF CONTINUES TO SUPPORT FROM REAR. QUESTIONS? OVER.
		ON PLATOON NET	
	5 -510	60. "36. NO QUESTIONS. WILCO. OUT."	
	5 -515	"64. SAME. OUT."	
	5 -520	"27. SAME. OUT."	

Frame: 14



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APPENDIX B

FUNCTIONAL CAPABILITY
RATING SCALES

APPENDIX B

FUNCTIONAL CAPABILITY RATING SCALES

Functional Capability Considerations For Exercising Platoon Leader Tasks: Terrain Representation

Terrain Representation: To what extent does the represented terrain allow the platoon leader to realistically determine ranges, obtain line of sight and acquire targets.

1.0 Represented terrain allows platoon leader to have the same visual access of the battlefield as under combat conditions.

0.8 Allows for two dimensional representation with three dimensional cues, including range determination, line of sight, dead space, and target masking.

0.6 Allows for two dimensional representation, including range determination, line of sight, dead space, and target masking.

0.4 Allows for two dimensional representation with range determination, limited line of sight, dead space, and target masking.

0.2 Allows for two dimensional representation with range determination only.

0.0 Represented terrain does not allow platoon leader to realistically determine ranges, obtain line of sight, and acquire targets.

Functional Capability Considerations
For Exercising Platoon Leader Tasks:
Visual Observation Technique and Visual Representation

Visual Observation Technique and Visual Representation: To what extent does the device allow the platoon leader to enagage in the same personal observation techniques and have the same visual representation as would occur on the battlefield.

1.0 Device fully simulates all available visual observation techniques (e.g., binoculars, tank commander's sight, thermal imagery sight) and all changes in the visual environment brought about by changes in tank position.

0.8 Device functionally simulates all visual observation techniques (e.g., selected fields of view, magnification capability stemming from use of binoculars and tank commander's sight) and all changes in the visual environment brought about by changes in tank position.

0.6 Device partially simulates visual observation techniques. Changes in the visual environment are partially simulated.

0.4 Device allows selected fields of view but not magnification capability. Simulation of changes in the visual environment is limited.

0.2 Device provides an unchanging field of view, but still requires visual observation to detect targets.

0.0 Device precludes the need to engage in any visual observation technique.

Functional Capability Considerations
For Exercising Platoon Leader Tasks:
Inputs to the Platoon Leader

Inputs to the Platoon Leader: To what extent does the device permit the platoon leader to receive realtime battlefield cues and tactical communications.

1.0 Simulates realtime receipt of all tactial voice communication, audio and visual battlefield cues, and visual communication signals.

0.8 Receipt of limited tactical voice communication, plus audio and visual battlefield cues, and visual communication signals.

0.6 Receipt of tactical voice communication through visual techniques (e.g., symbology, text) plus audio and visual battlefield cues, and visual communication signals.

0.4 Receipt of tactical voice communication through visual techniques and limited audio and visual battlefield cues.

0.2 Voice simulation not present; limited battlefield cues.

0.0 Device does not simulate realtime tactical voice communication, nor battlefield cues, nor visual communication signals.

Functional Capability Considerations
For Exercising Platoon Leader Tasks:
Platoon Leader Outputs

Platoon Leader Outputs: To what extent does the device allow the platoon leader to realistically communicate directions, request and provide information, and request combat support.

1.0 Simulates realtime transmission of all tactical voice communication and visual communication signals.

0.8 Simulates limited transmission of tactical voice communication and visual communication signals.

0.6 Transmission of tactical voice communication through non-auditory techniques (e.g., special keyboard, text) and limited simulation of visual communication techniques.

0.4 Transmission of limited tactical voice communications through non-auditory techniques (e.g., standard keyboard, text) and limited simulation of visual communication techniques.

0.2 Transmission of limited tactical voice communications through non-auditory techniques (e.g., standard keyboard, text).

0.0 Device does not simulate tactical voice transmission nor visual communication signals.

Functional Capability Considerations For Exercising Platoon Leader Tasks: Directing Control of Engagement

Directing Control of Engagement: To what extent does the device allow the platoon leader to perform all pertinent elements of fire control which direct the engagement of the platoon and supporting weapon systems.

1.0 Device allows platoon leader to issue initial engagement commands, make corrections, issue subsequent commands in real-time to platoon tanks, his own tank, supporting weapon systems, and provides for a real-time response.

0.8 Device allows platoon leader to issue initial engagement commands, make corrections, issue subsequent commands in real-time to platoon tanks, his own tank, supporting weapon systems, and provides for a partial real-time response.

0.6 Device allows platoon leader to issue initial engagement commands, make corrections, issue subsequent commands in near real-time to platoon tanks, his own tank, supporting weapon systems, and provides for a partial real-time response.

0.4 Device allows platoon leader to issue initial engagement commands, make corrections, and issue subsequent commands in expanded time to platoon tanks, supporting weapon systems, and provides for a limited real-time response.

0.2 Device allows platoon leader to issue initial engagement commands, make corrections, and issue subsequent commands in expanded time to platoon tanks, but does not provide for any response from platoon tanks.

0.0 Device allows for only a limited issuance of initial engagement commands, corrections, and subsequent commands.

Functional Capability Considerations
For Exercising Platoon Leader Tasks:
US and OPFOR Weapons Representation

US and OPFOR Weapons Representation: To what extent does the device allow for realistic simulation of US and OPFOR weapon firings and reactions to return fire.

1.0 Device fully simulates all visual and auditory aspects of weapon firings to include weapon signatures and projectile impact, projectile flight time, hit probability, and reactions to return fire.

0.8 Device fully simulates all visual and auditory aspects of weapon firings to include weapon signatures and projectile impact, projectile flight time, limited hit probabilities, and limited reactions to return fire.

0.6 Device simulates partial visual and auditory aspects of weapon firings to include limited weapon signatures and projectile impact, limited projectile flight time, and limited hit probabilities.

0.4 Device simulates partial visual and auditory aspects of weapon firings to include limited weapon signatures and projectile impact, and limited projectile flight time.

0.2 Device simulates partial visual aspects of weapon firings to include weapon signatures.

0.0 Device does not allow for simulation of weapon firings.

Functional Capability Considerations
For Exercising Platoon Leader Tasks:
US and OPFOR Vehicle Representation

US and OPFOR Vehicle Representation: To what extent does the device allow for vehicle representation, movement, and movement rates.

1.0 Provides three dimensional visual simulation of actual vehicles, realistic vehicle movement, and movement rates as would be observed from the vantage point of the platoon leader.

0.8 Provides two dimensional representation with three dimensional cues of vehicles, realistic vehicle movement, and movement rates as would be observed from the vantage point of the platoon leader.

0.6 Allows for two dimensional military symbol representation of vehicles, realistic movement, and movement rates.

0.4 Allows for two dimensional symbol representation of vehicles with partial vehicle movement capability, and realistic movement rates.

0.2 Allows for two dimensional symbol representation of vehicles and limited capability of both movement and movement rates.

0.0 Does not allow for vehicle representation, movement and movement rates.

Functional Capability Considerations For Exercising Platoon Leader Tasks: Smoke Screen Representation

Smoke Screen Representation: To what extent does the device allow for smoke screening by on-board tank and indirect fire delivery systems.

1.0 Fully simulates all smoke producing systems with respect to smoke generation capability, real-time coverage (initial generation and sustainment), dissipation (wind speed and direction) and degradation of hit probability.

0.8 Functionally simulates all smoke producing systems with respect to smoke generation capability, real-time coverage (initial generation and sustainment), dissipation (wind speed and direction) and degradation of hit probability.

0.6 Functionally simulates all smoke producing systems with respect to smoke generation capability and degradation of hit probability; however, real-time coverage and and dissipation is approximated.

0.4 Partially simulates most of the smoke producing systems with respect to smoke generation capability and approximates real-time coverage and dissipation.

0.2 Partially simulates either on-board or indirect fire smoke producing systems with respect to smoke generation capability, but does not approximate real-time coverage and dissipation.

0.0 Device does not allow for the simulation of smoke producing sytstems.

Functional Capability Considerations
With Respect To Instructional Features:
Familiarization and Initialization

Familiarization and Initialization: To what extent is the device conducive to efficient and easy to master familiarization and initialization procedures.

1.0 Device and associated software provide completely transparent functions for device mastering (e.g., cues, prompts, help key, human factored layout and labeling), ease of student response and data entry methods (e.g., touch pad), rapid log-on and log-off procedures, quickly accessed displays, and self-teaching modes for student/instructor.

0.8 Device and associated software features likely to provide moderate help and prompting capability, easy student response and data entry methods, quick log-on/log-off procedures, quickly accessed displays, and some self-teaching capability for student/instructor.

0.6 Device and associated software features provide only some help and prompting functions, adequate student response and data entry methods, reasonable log-on/log-off procedures, moderate display access time, and minimal self-teaching capability for student and instructor.

0.4 Help and prompting functions not provided, adequate student response and data entry methods, reasonable log-on/log-off procedures, slow display access time, and minimal self-teaching capability for student/instructor.

0.2 Adequate student response and data entry methods, cumbersome log-on/log-off procedures, and very slow display access time.

0.0 Inadequate student response and data entry methods, cumbersome log-on/log-off procedures and exceedingly slow display access time.

Functional Capability Considerations
With Respect To Instructional Features:
Instructional Presentation

Instructional Presentation: To what extent is the device conducive to instructional presentation methods that are challenging and captivating for different proficiency entry levels.

1.0 Device will fully support instructional presentation methods that challenge the student (e.g., variable difficulty level, variable pacing for information processing tasks, uncertain outcomes, random access of material, hidden information, increasing levels of performance criteria), allow exercise parameters and conditions to be reset for creation of new exercises, and allows for the creative use of mixed media.

0.8 Device likely to support variable difficulty levels, variable pacing for information processing tasks, uncertain outcomes, random access of material, hidden information, increasing levels of performance criteria, exercise parameters that can be changed to create new exercises, varing student entry levels, and the creative use of mixed media.

0.6 Device will provide support only for variable difficulty levels, some variable pacing for information processing tasks, uncertain outcomes, random access of material, fixed performance criterion levels, limited exercise parameters that can be changed for the creation of new exercises, varying student entry levels, and limited use of mixed media.

0.4 Device will provide support for limited variable difficulty levels, fixed pacing for information processing tasks, limited uncertain outcomes, limited random access of material, fixed performance criterion levels, constant exercise parameters, varying student entry levels, and limited use of mixed media.

0.2 Device will provide support only for singular difficulty level, fixed unrealistic pacing for information processing tasks, uncertain outcomes, considerably limited fixed performance criteria, constant exercise parameters, limited student entry levels, and predominant use of a single meduim.

0.0 Device will provide support only for singular difficulty level, unrealistic time demands for information processing tasks, predictable outcomes, constant exercise parameters, fixed student entry level, and sole use of a single medium.

Functional Capability Considerations
With Respect To Instructional Features:
Receipt of Feedback

Receipt of Feedback: To what extent is the device conducive to the receipt of feedback to student and instructor alike regarding both on-going consequences of actions taken during the exercise and summative measures of student performance.

1.0 Device and associated software are fully capable of incorporating the receipt of response-contingent feedback during exercises, free-play interaction in real-time, instructor monitoring capability, error control and instructor interdiction options, time-tagged performance record, situation playback, summative anaylsis of performance, and diagnostic feedback on specific tactical deficiencies.

0.8 Device and associated software are likely to incorporate response-contingent feedback during exercises, free-play interaction in close to real-time, instructor monitoring capability, error control and instructor interdiction, time-tagged performance record, situation playback, summative analysis of performance, and diagnostic feedback on specific tactical deficiencies.

0.6 Device and associated software will incorporate some response-contingent feedback during exercises, free-play interaction in close to real-time, time-tagged performance record, instructor monitoring and summative analysis of performance.

0.4 Device and associated software will incorporate limited response-contingent feedback during exercises, limited free-play interaction and summative analysis of performance.

0.2 Device and associated software will incorporate time-tagged performance record and summative analysis.

0.0 Device and associated software will not incorporate response-contingent feedback during exercises nor free-play interaction in close to real-time, nor time-tagged performance record, nor summative analysis.

Functional Capability Considerations
With Respect To Instructional Features:
Administrative/Management Duties

Administrative/Management Duties: To what extent is the device conducive to efficient administrative and management functions.

1.0 Device allows for complete administrative and management functions--instructor access to platoon roster, student files, exercise control, record-keeping and undating of new information --thereby minimizing preparation and administrative time.

0.8 Device likely to allow for most administrative and management functions--instructor access to platoon roster, student files, exercise control, record-keeping, and updating of new information --thereby minimizing preparation and administrative time.

0.6 Device allows for instructor access to platoon roster, student files, record-keeping, and updating of new information but limited exercise control.

0.4 Device allows for access to student records and files as well as updating but operation is inefficient.

0.2 Device offers the possibility for record management and updating but would cause a drain on existing resources.

0.0 Device offers no possibility for record management and updating.

APPENDIX C

FUNCTIONAL DESCRIPTIONS

APPENDIX C FUNCTIONAL DESCRIPTIONS

SUBSYSTEM: INPUT COMPONENT: KEYBOARD

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
QWERTY-TYPE KEYBOARDS	Aydin Controls 414 Commerce Drive Fort Washington, PA 19034 Executive Peripheral Systems 800 San Antonio Rd. Palo Alto, CA 94303 Genisco Computers 17805-D Sky Park Circle Drive Irvine, CA 92714 Sanders Associates, Inc. Daniel Webster Highway South Nashua, NH 03061 Tektronix, Inc. P.O. Box 500 Beaverton, OR 97077 Vector General 21300 Oxnard Street Woodland Hills, CA 91364	Keyboards are used primarily for entering alphanumeric data. Keyboards also have program function keys, cursor control keys and number pads. For key-controlled cursor movement, a cursor symbol is usually a block occupying a one-character area. Essentially all keyboards, except typeset, have letters in the same position (sometimes called QWERTY keyboards because of the first row of letters); however, considerable variation exists in the placement of the shift, return, and other special symbols as well as keyboard "feel". A pressed key generates a message in accord with a standard code, such as the American Standard Code for Information Interchange (ASCII) which uses an 8-bit code to represent letters, numbers, punctuation marks and special characters. While the keyboard is easily the most powerful input device, its weaknesses include the fact that few people type well and it lengthens the user interaction time to longer than real time. This is the least satisfactory way of interacting with graphic images.

SUBSYSTEM: INPUT

COMPONENT: KEYBOARD

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
SPECIALIZED CAPACITIVE KEYPAD	Cacti Computer Services 130 9th Street SW Portage La Prairie Monitoba Canada RIN 2N4 Cherry Electrical Products 3500 Sunset Avenue Waukegan, IL 60087	A capacitive keyboard uses switches which operate on the principle that changes in the closeness of conducting surfaces can cause a corresponding change in electronic signals. As a key is pressed, it moves a conducting plate closer to its mating plate, and the electronic circuits in the keyboard detect the change and send out the appropriate character code. Since the contacts do not touch, there is no contact wear and the life of the keyboard is limited only by the mechanical wear on the keys themselves (or sometimes by the wearing out of the spring or foam used to return the key and contact to the unpressed position). Capacitive keyboards can be made in flat, membrane form where the keys are part of a flat surface and do not move appreciably. This type of keyboard is inexpensive to manufacture and is often used for control panels and as keyboards for inexpensive games. The disadvantage to membrane keyboards is in the absence of movement or feedback to indicate a "pressed key".

SUBSYSTEM: INPUT

COMPONENT: LIGHT PEN

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
LIGHT PEN	Design Technology 7760 Vickers Street San Diego, CA 92111 Information Control Corp. 9610 Bellanca Avenue Los Angeles, CA 90045 Sanders Associates, Inc. Daniel Webster Highway S. Nashua, NH 03061	A light pen is used to track or locate points within the display area on a refreshed cathode ray tube (CRT). A refreshed CRT is the only type of display that can be used with a light pen because it responds to the instantaneous peak in brightness when the electron beam excites the CRT phosphor at that point. Light pens are highly dependent on software support for their useful operation. The resolution of light pens is poor in comparison to the resolution of a tablet and cursor However, light pens are suitable for pointing at graphic objects. Light pens are the only device other than the touch panel that physically touch the screen surface.

SUBSYSTEM: INPUT

COMPONENT: DIGITIZER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
TOUCH-SENSITIVE DIGITIZER	Elographics, Inc. 1976 Oak Ridge Turnpike Oak Ridge, TN 37830 TSD Display Products 35 Orville Drive Bohemia, NY 11716	Touch-sensitive digitizers, used as soft keyboards or graphics tablets, come in various sizes and are activated by a finger touch or unattached stylus. The finger or stylus causes a deformable cover-sheet with a conductive layer to contact a resistive substrate. The voltage picked off at the point of contact is digitized to provide x, y coordinates which are transmitted to the computer system for processing. The activation force is controlled by the amount of separation between the deformable cover sheet and the resistive substrate.

SUBSYSTEM: INPUT

COMPONENT: DIGITIZER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
ELECTROMAGNETIC DIGITIZER	Altek Corporation 2150 Industrial Parkway Silver Spring, MD 20904 GTCO Corporation 1055 First Street Rockville, MD 20850 Houston Instrument One Houston Square Austin, TX 78753 Instronics Inc. Suite 204, Bridge Plaza Ogdensburg, NY 13669	Digitizers are used to determine the location of a point in relation to a permanent frame of reference. The output is a pair of x,y coordinates. Electromagnetic digitizers generate a magnetic field through a protectively covered grid surface consisting of thousands of interwoven conductors (e.g., an 11 x 11 inch surface of 0.001 inch resolution would have 11,000 x 11,000 conductors). A positioning tool or cursor device with at least one button to activate the digitizing process picks up pulses from the horizontal and vertical conductors and transmits them to a control unit where they are decoded to determine the position of the point of contact.

SUBSYSTEM: INPUT

COMPONENT: DIGITIZER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
SONIC DIGITIZER	Science Accessories Corp. 970 Kings Highway West Southport, CT 06490	To determine location of a point, sonic digitizers emit sound impulses at the tip of special stylus. The time intervals for the sound to reach the sensors (either point microphones or microphone strips) are translated into distance measurements that yield xy coordinates of the stylus tip. Sonic digitizers can be used on any flat surface including a projection screen or CRT. Background noise, if excessive, can impair performance.

SUBSYSTEM: INPUT

COMPONENT: DIGITIZER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
LIGHT-DETECTOR DIGITIZER	Carroll Mfg. Company 1212 Hagan Champaign, IL 61820 Maganavox Display Systems 2131 South Coliseum Blvd. Fort Wayne, IN 46803	Light-emitting diodes and photodectors are installed on the opposite vertical and horizontal sides of a frame to set up a matrix of infrared light beams which when intercepted by a finger or stylus generates coordinates of the intercepted point. Light-detector digitizers have been used as accessories for both plasma panel displays and CRTs. Resolution of approximately 0.25 inch is not as good as other digitizers, but more than adequate for selection from a menu. Although these digitizers are referred to as touch panels, the infrared beams are projected across but slightly above the surface of the screen precluding the necessity to actually touch the screen. This distinction is moot to most users since touching the screen insures the beams will be intercepted.

SUBSYSTEM: INPUT COMPONENT: CURSOR CONTROLLER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
JOYSTICK	Aydin Controls 414 Commerce Drive Fort Washington, PA 19034 Genisco Computers 17805-D Sky Park Circle Drive Irvine, CA 92714 Measurement Systems, Inc. 121 Water Street Norwalk, CT 06854 Megatek Corporation 1055 Shafter Street San Diego, CA 92106 Sanders Associates, Inc. Daniel Webster Highway South Nashua, NH 03061 Tektronix, Inc. P.O. Box 500 Beaverton, OR 97077	Joysticks are used for cursor symbol control to indicate the direction, speed, and duration of the display cursor. Two components of the joystick are the handle and the base (containing sensor). Input data in the form of an analog signal is passed from the sensor to a control unit that converts the signal to suitable digital format. The joystick can be pushed or pulled in any arbitrary direction. As a cursor control device, it is quite fast. Accurate placement reqiures practice.

SUBSYSTEM: INPUT

COMPONENT: CURSOR CONTROLLER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
DISPLACEMENT JOYSTICK	Aydin Controls 414 Commerce Drive Fort Washington, PA 19034	The displacement joystick is the most popular and economic device for interactive graphics use. The speed of cursor movement is proportional to the magnitude of the handle displacement from upright position. The handle returns to vertical upon release by means of a spring-return feature. A potentiometer sensor picks up the angle of displacement in the four directions and generates four analog signals.

SUBSYSTEM: INPUT

COMPONENT: CURSOR CONTROLLER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
FORCE-OPERATED JOYSTICK (Also known as Stiffstick or Isometric Joystick)	Measurement Systems, Inc. 121 Water Street Norwalk, CT 06854	Force-operated joysticks provide extremely fast response and greater accuracy than other types. The handle of this device feels stiff. Cursor speed is directly proportional to the pressure applied to the joystick, although there is no discernable deflection to the stick. The cursor stops immediately upon release of the joystick. Momentary applications of pressure move the joystick one unit of resolution at a time for accurate positioning. User can control a third dimension by exerting torque on the joystick by means of an overhead mounted hand grip.

SUBSYSTEM: INPUT

COMPONENT: CURSOR CONTROLLER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
SWITCH-ACTIVATED JOYSTICK	Measurement Systems, Inc. 121 Water Street Norwalk, CT 06854	The base of the joystick is connected to eight switches, corresponding to eight points of the compass. Direction of movement is limited to these eight points. Tilting the joystick in a given direction causes the switch closest in position to the direction to be activated, as long as the stick remains in that position. Limitation to eight directions severely restricts freedom of interaction.

SUBSYSTEM: INPUT

COMPONENT: CURSOR CONTROLLER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
THUMB WHEELS	Measurement Systems, Inc. 121 Water Street Norwalk, CT 06854	Thumb wheels are easy to use and provide for accurate cursor control but are tedious to use for motion in a diagonal direction. Thumb wheels are used for cursor control along an x- and y-axis. Two wheels are usually mounted at right angles to each other on the side of a graphics terminal keyboard.

SUBSYSTEM: INPUT

COMPONENT: CURSOR CONTROLLER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
TRACKBALL	Aydin Controls 414 Commerce Drive Fort Washington, PA 19034 Measurement Systems, Inc. 121 Water Street Norwalk, CT 06854	A trackball is generally a sphere (approximately 3 inches) that can be rotated with the palm of the hand for cursor control applications calling for high precision. It uses a potentiometer sensor or four optical encoders which count the increments of ball rotation in each of the four directions. Associated electronic circuits convert the pulse streams into digital data indicating direction and distance of trackball rotation. The ratio of cursor distance to trackball rotation can be adjusted to suit the particular application. Higher precision results in slower operation because the user must turn the ball more revolutions. This allows for gradual movement in a dense display area.

SUBSYSTEM: INPUT

COMPONENT: CURSOR CONTROLLER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
DIAL	Measurement Systems, Inc. 121 Water Street Norwalk, CT 06954	A dial serves as a one-axis cursor control device. A clockwise turn of the dial moves it in one direction; a counter clockwise turn moves it in the opposite direction. It uses a potentiometer sensor that operates like a single-axis joystick. Upon release, a spring return brings the dial back to the center position. Other types of dials simply stay in the last occupied position upon release.

SUBSYSTEM: INPUT

COMPONENT: MOUSE

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
MECHANICAL MOUSE	3G Company Rt 3, Box 28A Gaston, OR 97119 Product Associates, Inc. 465 Convention Way Redwood City, CA 94063 Summagraphics 35 Brentwood Ave. Fairfield, CT 06430 The Mouse House A Division of Hawley Lab 1741 8th Street Berkeley, CA 94710	The original mechanical mouse is simply a box that rolls on two wheels placed at right angles to one another. When it rolls forward, one wheel rotates freely while the other skids along without turning. Each wheel turns in direct proportion to the extent of forward or lateral motion. A signal converter translates wheel motions to electronic signals that the computer can read. An improvement over the use of potentiometers is the use of stainless steel ball bearings which eliminate the drag of the nonrolling wheel. Mechanical mice are used for cursor control, command and menu selection and crude graphics. Entries are made through buttons on the mouse.

SUBSYSTEM: INPUT

COMPONENT: MOUSE

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
OPTICAL MOUSE	USI Computer Products 71 Park Lane Brisbane, CA 94005 Mouse Systems Corporation 2336 H. Walsh Ave. Santa Clara, CA 95051	The optical mouse uses no moving parts to detect its motion. As the mouse slides over an array of dots on a special pad, a tiny lamp illuminates the dots and an image is refelcted by a mirror and focused through a lens onto an integrated-circuit sensor chip. The chip recognizes the pattern of dots before the mouse moves, remembers that pattern, and compares it to the new pattern of dots it sees during and after *the mouse's movement*. In this way, it determines the direction of motion and distance travelled. Finally, it translates the information into digital form that tells the computer how to move the cursor on the screen in a corresponding manner.

SUBSYSTEM: INPUT

COMPONENT: MOUSE

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
THE DEPRAZ MOUSE	Logitech, Inc. 165 University Ave., #105 Palo Alto, CA 94301	A third type of mouse is a hybrid between the mechanical and optical mouse: tracking is done mechanically and encoding is done optically. It uses an optical-scanning technique to detect mouse motions and translate them to digital signals. This mouse is generally referred to as the Depraz or "Swiss" mouse.

SUBSYSTEM: INPUT

COMPONENT: VOICE PROCESSING UNIT

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
VOICE ENTRY UNITS	Interstate Electronics Corp. P.O. Box 3117 Anaheim, CA 92803 Periphonics 4000 Veterans Memorial Highway Bohemia, NY 11716	Voice entry units allow the user to input commands using speech. They are used to replace or supplement other input devices and are especially useful in applications where hands and eyes of the user are occupied. Voice entry units include speaker dependent and independent word recognition.
Speaker-Dependent	Savvy Marketing International 100 S. Ellsworth Street 9th Floor San Mateo, CA 94401 Texas Instruments Data Systems Group P.O. Box 402430, H-648 Dallas, Texas 75240 Threshold Technology, Inc. 1829 Underwood Boulevard Delran, NJ 08075	Speaker dependent word recognition is typically used in applications such as data entry and retrieval, equipment control, and transaction processing. User training is required. The system stores a digital copy or template of the spoken word in vocabularly memory. When a word is spoken during operation the system compares a digital copy of the trail word to each stored template and selects the best fit. Some vendors claim a 99+% accuracy on industry standard for voice recognition, noise immunity in loud background noise environments, and one or two training trials for each voacbularly entry. High accuracy, excellent noise immunity, one or two training trials are attractive properties.

SUBSYSTEM: INPUT/OUTPUT

COMPONENT: VOICE PROCESSING UNIT

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
Speaker-Independent	Votan 4487 Technology Drive Fremont, CA 94538	Speaker independent word recognition units are operated by speaking a word without prior, individualized training. They are used in applications where it is not possible to train user base such as the general public or numerous employees. It can be used to log on users before the speaker dependent recognition templates are loaded from a host computer. For each word, the system contains a factory generated template that represents a composite of statistically sampled utterances of that word. A digital copy of the trial word is compared for the best fit with each composite template stored in memory.
Voice Store And Forward Units		Voice store and forward is useful for continuously changing messages which are briefly stored. A typical application is voice mail where messages can be easily retrieved, updated and distributed. Digitized speech is transmitted and stored in an electronic "mailbox", usually resident on a disk drive, and later is retrieved by the called party.

SUBSYSTEM: INPUT COMPONENT: WRITER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
VIDEO FREE-HAND WRITER	For-A Corporation of America 49 Lexington Street W-Newton, MA 02165 Interand Corporation 666 North Lake Shore Dr. Chicago, IL 60611	Video free-hand writers allow images to be drawn directly on the monitor by using a stylus. Writing, drawing and rapid notations are executed smoothly. The image is drawn over the video image and can be partially erased or instantly deleted. Image intensity is variable from black to white and can be controlled by the user. Some systems, however, allow the selection of preprogrammed symbols as well. These systems accept video input from tape, film or slide sources. The user is then able to annotate or animate the background image shown on the monitor screen.

SUBSYSTEM: INPUT

COMPONENT: WORKBOOK

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
WORKBOOK	Custom designed	As a basic student input system, workbooks are usually custom designed for specific instructional purposes. They may be used with or without the aid of an instructor, slides, and audio cassettes in either self-paced or time-paced modes. A basic feature of many workbooks is the incorporation of practice or unit exercises where the student is placed in the midst of a realistic situation or problem to which he or she must respond. In brief, most workbooks attempt to actively involve the student in the instructional material rather than impart knowledge in a passive manner.

SUBSYSTEM: INPUT/CONTROL

COMPONENT: MANUAL CONTROL

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
MANUAL CONTROL	Communications Televideo Limited 918 Sligo Ave. Silver Spring, MD 20910 Eastman Kodak Co. 343 State St. Rochester, NY 14650 Singer Education Systems 3750 Monroe Ave. P.O. Box 1371 Rochester, NY 14603	A manual control is a device which allows the user or instructor to operate audio visual equipment on a non-programmed or as needed basis. Manual controls, consisting of buttons, push-buttons, micro-switches, or dials, can serve as either a student response or controlling component. Ease of operation, low-cost and good reliability account for their popularity.

SUBSYSTEM: INPUT

COMPONENT: AUDIO TAPE RECORDER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
AUDIO TAPE RECORDER	Ampex Corporation 401 Boradway Redwood City, CA 94063 Bell & Howell Co. Audio Visual Products 7100 McCormick Road Dept. 8876 Chicago, IL 60645 Telex Communications 9600 Aldrich Ave. S. Minneapolis, MN 55420	An audio tape recorder is a device used for making a permanent or temporary record of an audio signal or response. Audio tape recorders are frequently configured as playback devices as well. Signals may be recorded on cassette, cartridge or open reel tapes.

SUBSYSTEM: INPUT/OUTPUT

COMPONENT: AUDIO-VISUAL

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
PROGRAMMED INSTRUCTION EQUIPMENT	Centurion Industries 167 Constitution Dr. Menlo Park, CA 94025 Dorsett Educational Systems, Inc. P.O. Box 1226 Norman, OK 73070 LaBelle Industries 510 S. Worthington P.O. Box 128 Oconomowoc, WI 53066	Several different configurations of programmed instruction equipment are commercially available. Some have a built-in screen through which the student receives programmed audio and visual instruction in a multiple choice format. The student responds by pressing a correct button or key and the program advances either automatically or manually. Other types include programmable microcomputers. Typically, self-contained programs display specific questions to the student; the student presses appropriate keys to respond. There are usually 10-30 questions per program, a score at the end of a series and an automatic review to identify problem areas. Variable speed projectors with program pause capability are also used for programmed instruction.

SUBSYSTEM: STORAGE

COMPONENT: TAPE

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
CASSETTE TAPE	3M Department PM-E3 Data Recording Products Division P. O. Box 33133 St. Paul, MN 55133 Radio Shack/Tandy 300 One Tandy Way Fort Worth, TX	A cassette tape stores digital data on regular cassette tapes. A cassette tape can store tens of thousands of bytes of computer information or instructions. However, it offers serial access only. That is, each byte must be read one at a time. Therefore, it is slow and time consuming, although 90 percent cheaper than floppy disk drives. In addition, operator interaction is usually required to provide frequent interchange of cassettes, due to their relatively limited storage.

SUBSYSTEM: STORAGE

COMPONENT: TAPE

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
$\frac{1}{4}$" DATA CARTRIDGE	3M Department PM-E3 Data Recording Products Division P.O. Box 33133 St. Paul, MN 55133 Data Electronics, Inc. San Diego, CA 92121	The data cartridge storage medium uses $\frac{1}{4}$ inch tape enclosed in a single cartridge employing multiple tracks (up to 16). The DCD-3 data cartridge drive uses the DC300A/DC100A type data cartridge which is capable of storing up to 19 megabytes. For more capacity, the HDC-75 provides 67 megabytes with block addressable capability. Areas of use for this type of storage range from on-line (although relatively slow) storage to Winchester hard disk backup. The primary advantages of data cartridge storage include low-cost reliable storage with high capabilities available.

SUBSYSTEM: STORAGE COMPONENT: DISK

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
FLOPPY DISK	A. M. Electronics 3446 Washtenaw Ave. Ann Arbor, MI 48104 Amdek 2201 Lively Blvd. Elk Grove Village, IL 60007 ASAP Computer Products 1198 E. Willow St. Signal Hill, CA 90806 BASAF Systems Crosby Drive Bedford, MA 01730 Chrislin Industries, Inc. 31352 Via Colinas Westlake Village, CA 91362 Cromemco, Inc. 280 Bernardo Ave. Mountain View, CA 94040	Mass storage is a medium which will hold, more or less permanently, large amounts of digital information or bytes. The most common forms are floppy disks, hard disks and cartridge tape. A disk is operated with a disk drive, a mechanical device that acts much like a stereo player when its needle picks up sounds from a record. The disk drive system picks up digital signals stored on the disk and transmits the data in electronic pulses to the computer. Disks are used to hold programs, data bases and documents. They are used as working storage during sorts and merges and for data achiving ("off-line" storage). An additional use is for transporting data and programs between systems. A diskette (or floppy disk) is a magnetically treated circular sheet of flexible plastic (mylar) that is encased in a series of magnetic traces. Its principal use is to store programs and feed them into the computer. Each typically holds the equivalent of about 35-140 single-spaced pages of information, depending on the computer. Various floppies can store various amounts of information because they have differenct densities. Standard is single-density, while double-density puts twice as much information into the same amount of space. Floppies can be either single- or double-sided and come in 3 sizes - a standard 8 inch, 5¼ inch and new 3 inch disks. While

SUBSYSTEM: STORAGE

COMPONENT: DISK

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
FLOPPY DISK	Dysan Corporation Corporate Headquarters 5201 Patrick Henry Dr. Santa Clara, CA 95050 Omni Resources Corp. 4 Oak Pond Ave. Milbury, MA 01527 Trak Microcomputer Corp. 1511 Ogden Ave. Downers Grove, IL 60515	the $5\frac{1}{4}$ inch costs less, the 8 inch floppy is significantly faster and has a greater storage capacity. While less expensive, floppy disks are much slower than Winchester hard disks.

SUBSYSTEM: STORAGE

COMPONENT: DISK

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
WINCHESTER HARD DISK	Alspa Computer Inc. 300 Harvey West Blvd. Santa Cruz, CA 95060 Ampex Corporation Memory Products Division 200 N. Nash Street El Sequndo, CA 90245 AMT Route 30 West Greengate Professional Bldg. Greensburg, PA 15601 CMC International 11058 Main, Suite 220 Bellevue, WA 98004 Control Data Corp. Minneapolis, MN. 55440 Corona Data Systems, Inc. 31324 via Colinas, Suite 110 Westlake Village, CA 91361	Instead of thin flexible plastic used in floppies, the Winchester hard disks use machined aluminum platters covered with a metallic surface. Because the disk surface is usually sealed inside a dust free environment, the magnetic heads can sweep near the surface without touching it (therefore without wear and tear). The storage capacity is high - typically 5 megabytes or more. This large storage capability is the primary advantage of hard disk storage over floppy disks as well as the increased reliability due to the sealed media. Winchester disk storage is the most expensive storage medium.

SUBSYSTEM: STORAGE

COMPONENT: BUBBLE MEMORY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
BUBBLE MEMORY	Intel Corporation, Ltd. Dept. #Y-2 3065 Bowers Ave. Santa Clara, CA 95051	Magnetic bubble memory is a solid-state, nonvolatile technology that features high density, small size, light weight and limited power dissipation. A magnetic bubble memory stores data in magnetic domains or "bubbles" in a thin film on a garnet chip. A bubble memroy module board gives a full megabyte of solid state memory. The data access speed is about three times the speed of a floppy disk. Because the Intel 7110 bubble is non-volatile, it retains memory when the system power is off and requires no battery back up.

SUBSYSTEM: STORAGE

COMPONENT: VIDEODISC

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
CAPACITANCE VIDEODISC	RCA Corporation Videodisc Division 600 Sherman Drive P.O. Box 1976 Indianapolis, IN 46206	The capacitance approach to videodisc technology exchanges the optical disc's endurance and versatility for technically less complex, and therefore less expensive equipment. Various means are used to pick up electrical capacitance signals pressed into the disc. There are two types of capacitance systems. On both types of capacitance videodiscs, picture and sound information is encoded as microscopic pits much larger than the pits on optical discs. A stylus electrode picks up the information in the form of capacitance variations between it and the surface of the disc without making actual contact. In the second type of system, the pickup stylus is in physical contact with the disc and therefore some wear will occur. However, hundreds of plays are possible without noticeable degradation of the picture or sound.

SUBSYSTEM: STORAGE | COMPONENT: VIDEODISC

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
OPTICAL VIDEODISC	Digital Controls Video Group 2551 Blairstone Pine Dr. Suite 101 Tallahassee, FL 32301 Discovision Associates 3300 Hyland Ave. P.O. Box 6600 Costa Mesa, CA 92626 Optical Recording Project 223-5S 3M Center St. Paul, MN 55144 Pioneer Video, Inc. 200 West Grand Ave. Montvale, NJ 07645 Sony Communications Products Co. Sony Drive Park Ridge, NJ 07656 WICAT Systems P.O. Box 539 1875 South State Street Orem, UT 84057	There are two types of optical videodiscs: transmissive and reflective. With both types of optical systems, a laser beam strikes microscopic pits on the disc's surface, which interrupts the beam. This interrupted beam is then translated into both video and audio information which is played back on a television receiver or monitor. Some optical systems use reflective discs with the light beam bouncing off the disc's surface, while the transmissive disc allows light to pass through to a detector on the other side. The laser beam picks up the information without making physical contact with both reflective and transmissive discs (thus saving wear and tear). Its features include the ability to still frame (i.e., play a single frame indefinitely for detailed study) and rapid access of frames. Transmissive discs are easier to reproduce than reflective discs and by refocusing the laser, both sides of the disc can be played without turning it over. Three types of optical videodisc units include (1) the basic optical videodisc playable on a commercial player (without computer programming), (2) videodisc controlled by a program recorded on the disc and executed by a microprocessor built into the player and (3) videodisc controlled by an external computer program, with a high level of interactivity (e.g., graphic overlays, touch/voice input). The above three types of videodisc units are sometimes referred to as manual (level I), industrial (level II), and intelligent (level III), respectively.

SUBSYSTEM: STORAGE

COMPONENT: TAPE

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
AUDIO/VIDEO TAPE, CASSETTE, CARTRIDGE, and OPEN REEL	Bell & Howell Company Audio Visual Products 7100 McCormick Road Dept. 8876 Chicago, IL 60645 Panasonic Industrial Co. Video Systems Division Matsushita Electric Corp. of America 1 Panasonic Way Secaucus, NJ 07094 Sony Corporation of Am. 9 W. 57th St. New York, NY 10019	A cassette or cartridge is an enclosed case with feed and take up reels holding magnetic audio tape or video tape. Cassettes and cartridges contain and protect the tape during storage and playback and obviate the necessity for threading the tape for playback. The cartridges and cassettes also allow material to be recorded. Audio or video tape mounted on a reel that is not enclosed in a cartridge or cassette case is called an open reel.

SUBSYSTEM: STORAGE

COMPONENT: FILM

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
MOTION PICTURE OR STILL PHOTOGRAPH FILM	Bell and Howell Company Audio Visual Products 7100 McCormick Rd. Dept. 8876 Chicago, IL 60645 Eastman Kodak Co. 343 State St. Rochester, NY 14650 Elmo Mfg. Corporation 70 New Hyde Park Road New Hyde Park, NY 11040	Film is a plastic material coated with light-sensitive emulsion on which pictures may be photographed or it may consist of a plastic material coated with iron oxide particles on which magnetic tape may be recorded.

SUBSYSTEM: STORAGE

COMPONENT: FILM

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
FILMSTRIP	Audiscan Products Co. 1410 130th Ave. NE P.O. Box 1456 Bellevue, WA 98009 Radmar Inc. 1282 Old Stokie Rd. Highland Park, IL 60035 Singer Education Systems 3750 Monroe Ave. P.O. Box 1371 Rochester, NY 14603	A filmstrip is a series of transparent pictures on a single strip of 35mm or 16mm film. A filmstrip may be silent or provided with an accompanying sound program (tape or record). It can be advanced manually or, if equipped, automatically be utilizing a cue tone on the record or tape.

SUBSYSTEM: STORAGE

COMPONENT: CONTINUOUS LOOP

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
CONTINUOUS LOOP	Mackenzie Laboratories 5507 Peck Road Arcadia, CA 91006	A loop of film or tape made by splicing the ends together for continuous projection or playback operation is referred to as a continuous loop. This type of tape or film is typically enclosed in a special cartridge for insertion into a compatible projector, or audio tape recorder/player.

SUBSYSTEM: STORAGE

COMPONENT: MICROFORM

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
MICROFILM/MICROFICHE	Alan Gordon Enterprises 5362 Cahvenga Blvd. North Hollywood, CA 91601 Dukane Corporation 2900 Dukane Dr. St. Charles, IL 60174 Revox Systems Inc. 2224 Hewlett Avenue Merrick, NY 11566	Microfilm and microfiche consist of materials presented in micro-images too small to be read without the aid of magnification. Two principal types are microfiche and microfilm. Microfiche is a sheet of microfilm (usually 4"x 6") which contains multiple micro images in a grid pattern. Microfiche usually contains a title which can be read without magnification for identification ease. Microfilm is a filmstrip in which each frame is a miniaturized image of a printer page or photograph. Format sizes may be 16, 35, 70 or 105mm.

SUBSYSTEM: STORAGE/OUTPUT

COMPONENT: PHOTOGRAPH

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
PHOTOGRAPH	Photographic equipment is available from a wide variety of commercial sources. Professional photographers often operate on a free-lance basis.	Photographs are made by recording the subject on light sensitive film. Photography is a common technology today. Its primary advantages are easy availability, low-cost and high visual fidelity. The quality of the reproduced image varies with respect to the quality of the equipment used (e.g., camera, lens, film) and the means of development.

SUBSYSTEM: STORAGE/OUTPUT

COMPONENT: PRINT

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
PRINT	Customized and standard print materials are available from a wide variety of commercial sources.	Print is a way of representing information using symbols such as alphanumeric characters and handwriting. This does not include line graphics or pictures. Print is a commonplace presentation means and includes all printed text materials, papers, books, and magazines. Easily the cheapest and most frequently used method of communicating information.

SUBSYSTEM: STORAGE/OUTPUT

COMPONENT: HARD COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
GRAPHICS	Custom and standardized graphic materials may be purchased from a wide variety of graphics houses and/or free-lance graphic artists.	Graphic materials consist of hand drawn or printed charts, diagrams, graphs and pictures (not photographs) used in audio-visual presentations; easel graphics are graphics displayed on an easel or mounted on a wall; projected graphics are graphics made into slides, films or transparencies for projection on a screen.

SUBSYSTEM: CONTROL

COMPONENT: MICROCOMPUTER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
HAND-HELD COMPUTER (DEDICATED BUS)	Epson America, Inc. 3415 Kashiwa Street Torrange, CA 90505 Quasar Company 9401 West Grand Ave. Franklin Park, IL 60131 Panasonic Company Division of Matsushika Elec. Corp. of America One Panasonic Way Secqucus, NJ 07094 Radio Shack 6 East 39th Street Suite 401 New York, NY 10016 NEC Home Electronics 1401 Estes Ave. Elk Grove Village, IL 60007	The process of minaturization has allowed the development of completely portable hand-held computer systems. Generally these systems are small enough to fit in a brief-case and can run on an internal power supply for as much as 50 hours and recharge fully in about eight. Hand-held computers are built around a microprocessor (typically a 6502 chip) but due to their small size have somewhat limited memory capabilities when compared to larger desk-top computers. The memory varies but is usually about 16K bytes. Even so, the user has information handling and telecommunication capability and can write and store app-lications programs. Microsoft BASIC is frequently included in the language package. These portable computers interface with input/output and data storage peripherals and generally have limited graphics capability. Becuase of the small size of hand-held computers the screen or display is small also. Hand-held computers are used as portable data-base systems and problem solving devices in remote or harsh environments, as source data entry terminals that can send or receive messages from another computer, and as time-sharing terminals that can interact with a large centralized data base. Some hand-held computers are considered dedicated bus machines because of the inability of a non-standard bus to interface with peripherals from other vendors.

SUBSYSTEM: CONTROL

COMPONENT: MICROCOMPUTER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
DESKTOP MICROCOMPUTER (DEDICATED BUS)	Radio Shack 6 East 39th Street Suite 401 New York, NY 10016 Texas Instruments Consumer Products Group P.O. Box 10508,MS 5849 Lubbock, TX 79048	Typically utilizing an 8-bit chip, microcomputers with a dedicated bus are more limited than microcomputers with a standard bus. A bus is a set of wires and connections that link the various computer components (e.g., central processing unit, input/output ports, terminals, and interfaces). The standardization of the bus (e.g., the S-100 bus, an industry standard) makes it possible for more than one manufacturer to build products that will all plug together. A non-standard bus is referred to as a dedicated bus and allows only components from the same manufacturers to be used. This severely limits the growth potential and ties the user to a particular brand. Frequently, desktop microcomputers with dedicated buses are low-level, low-cost, hobbyist machines not suited for training purposes.

SUBSYSTEM: CONTROL

COMPONENT: MICROCOMPUTER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
8-BIT MICROCOMPUTER	Alspa Computer Inc. 300 Harvey West Blvd. Santa Cruz, CA 95060 Apple Computer 20525 Mariani Ave. Cupertino, CA 95014 Commodore Computer Systems Group 487 Devon Park Drive Wayne, PA 19087 Cromemco, Inc. 280 Bernardo Ave. Mountain Veiw, CA 94040 Digital Equipment Corp. One Iron Way Marlboro, MA 01752 Intel Corporation 3065 Bowers Ave. Santa Clara, CA 95051 Intertec Data Systems 2300 Broad River Road Columbia, SC 29210	A microcomputer can be defined as a complete system consisting of a microprocessor as its Central Processing Unit (CPU), memory, input/output (I/O) controllers, and ports. The CPU is a computer's main processing center which holds the control system, the arithmetic and logic units necessary to execute instructions, and some memory. The control system supervises the activity of the other subsystems. It directs the processing of input, storage and retrieval of information, arithmetic and logical processing, and output. Memory is the capability of a computer to store information either temporarily or permanently in the form of binary digits. There are basically two types of memory in a microcomputer: RAM and ROM. Random Access Memory (RAM) can be read from and written to. It is the kind of memory that can be used to hold application programs, compilers, transient data (data that are being transferred from one peripheral to another) as well as other software. RAM is measured in bytes or K bytes (K=1024 bytes). Read Only Memory (ROM) can be read from but not written to. This type of memory is preprogrammed and contains a fixed set of instructions. ROM usually contains programs which include routines for interacting with a computer system - such as altering or examining computer memory (ROM) locations. A bit is the smallest piece of data recognizable to a computer. The term is a contraction for binary digit. A byte consists of 8 binary bits of data grouped together to store a character of alphanumeric data so the size of

SUBSYSTEM: CONTROL COMPONENT: MICROCOMPUTER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
8-BIT (Continued)	North Star Computers, Inc. 14440 Catalina Street San Leandro, CA 94577 Osborne Computer Corp. 26538 Danti Court Hayward, CA 94545 Otrona Advanced Systems Corporation 4755 Walnut Street Boulder, CO 80301 Seequa Computer Corp. 209 West Street Annapolis, MD 21401 Sony Communications Products Co. Sony Drive Park Ridge, NJ 07656 Zilog, Inc. 10460 Bubb Rd. Cupertino, CA 95014	such items in memory can be interchangeably given in bytes or characters. Due to the fact that 8-bit microcomputers were the first type of microprocessor to be designed and developed in various systems, it follows that these 8-bit processors have the largest established software base. The ubiquitous CP/M operating system (Control Program for Microcomputers) primarily runs on the popular Z80A based machines. On the other hand, Apple computer utilizes the 6502 microprocessor to run the Apple operating system (Apple DOS) and related software. It should be noted that the Z80A microprocessor does not directly run Apple software and the Apple's 6502 microprocessor will not execute CP/M. Although not as popular as the Zilog Z80A or 6502, the Intel 8085 microprocessor has been implemented in various systems and is capable of running CP/M and most CP/M related software.

SUBSYSTEM: CONTROL COMPONENT: MICROCOMPUTER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
16-BIT MICROCOMPUTER	Corona 31324 Via Colinas Westlake Village, CA 91361 IBM Corporation Product Center 590 Madison Avenue New York, NY 10022 Northside 14440 Catalina Street San Leandro, CA 94577	The 16-bit microcomputer provides two basic improvements over 8-bit machines. First, the enhanced word width allows for greater overall throughput (i.e., processing power of the microcomputer). Virtually all 16-bit microcomputers have improved instruction execution times as well as better instruction sets when compared to their 8-bit counterparts. The other area of improvement is the ability of the 16-bit machines to directly access large amounts of memory with their extended address busses. Almost all 16-bit microcomputers can access up to 1 megabyte of memory, with 68000 processors capable of up to 16 megabytes of address space. With a megabyte or more of memory address space, intricate programs and high quality graphics are possible.
8088/8086 80186/80286	Texas Instruments P.O. Box 2909 Austin, TX 78769 Intel Corporation 3065 Bowers Ave. Santa Clara, CA 95051 NEC Home Electronics Personal Computer Div. 1401 Estes Avenue Elk Grove Village, IL 60007	Currently available microprocessors can be categorized by their 4 major vendors. The Intel family of microprocessors range from the 8088/8086 to the 80186/80286. The Intel 8088 is used in the IBM Personal Computer and uses the same 16-bit architecture as the 8086 but handles external data on an 8-bit bus; therefore, it is known as an 8/16 bit processor. On the other hand, the 8086 has an external 16-bit bus and therefore is classified as a 16/16 bit processor. The 80186 and 80286 are enhanced, higher

SUBSYSTEM: CONTROL   COMPONENT: MICROCOMPUTER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
16-BIT MICROCOMPUTER (continued)	Wang One Industrial Avenue Lowell, MA 01851	performance versions of the 8086 and are code compatible with the 8088/8086 and also other 16-bit microprocessors.
68000 68010 68020	Corvus Systems 2092 O'Toole Avenue San Jose, CA 95131 Gifford Computer Systems 1922 Republic Avenue San Leandro, CA 94577	The extremely popular Motorola family of processors range from the 68000 to the 68010 and 68020. The 68000 is an extremely powerful machine with a 16/32-bit architechture - 16-bit external bus and 32-bit internal architecture. The 68010 is an upgraded version of the 68000 which as the added feature of memory management for its 16 megabyte address space. Rounding out the Motorola family is the 68020 which is a true high performance 32/32-bit machine.
Z8001/Z8002	Hewlett-Packard Co. Personal Computer Div. 1010 NE Circle Drive Cavaillis, OR 97330	Not as popular as the other microprocessors, Zilog produces the Z8001/Z8002 16/16-bit processors. The Z8002 is used in limited applications requiring only 64K bytes of memory, while the Z8001 can address up to 8 megabytes.
	Motorola 3501 Ed Bluestein Blvd. Austin, TX 78721 Radio Shack 6 East 39th Street Suite 401 New York, NY 89502	By far the family with the most software available for the 16-bit processors is the LSI-11 and PDP-11/23 micro-processor line from Digital Equipment Corporation (DEC). Both of these processors are 16/16-bit machines that execute DEC's standard PDP-11 instruction set. This allows these processors to share the well

SUBSYSTEM: CONTROL

COMPONENT: MICROCOMPUTER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
16-BIT MICROCOMPUTER (continued)	Sage Computer Technology 35 N. Edison Way, Suite 4 Reno, NV 89502 WICAT Systems 441 Lexington Ave. Suite 608 New York, NY 10017 Zilog, Inc. 10460 Bubb Road Cupertino, CA 95014	established base of software for DEC's microcomputer products. The 68000 family of microprocessors is recognized as the most powerful 16-bit processor at this time, while the *PDP 11/23 family* has the largest *established* software base. The 8088/8086 processors are the least expensive and have a relatively large amount of available software, primarily for the IBM/PC. The Z8000 is not as popular as the other 16-bit machines, and as such is found primarily in dedicated applications.

SUBSYSTEM: CONTROL

COMPONENT: MICROCOMPUTER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
MULTIPLE MICROPROCESSORS	California Computer Products Inc. 2411 W. La Palma Ave. P.O. Box 3250 Anaheim, CA 92803 Sperry/Univac Univac Park P.O. Box 43525 St. Paul, MN 55164 Tektronix, Inc. 4900 SW Griffith Dr. Beaverton, OR 97005	Many higher level computers are configured with more than one microprocessor. This permits simultaneous processing by two or more processing units that share a common memory and peripheral devices. One such configuration may use one microprocessor for graphics purposes and another for various systems applications that occur at the same time. Computers with multiple microprocessors are well suited to sophisticated, high resolution graphics.

SUBSYSTEM: CONTROL   COMPONENT: VIDEO INTERFACE

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
VIDEO INTERFACE	Allen Communications 140 Lakeside Plaza II 5225 Wiley Post Way Salt Lake City, UT 84116 Pioneer Video, Inc. 200 West Grand Ave. Montvale, NJ 07645 Sony 9 West 57th Street New York, NY 10019	The purpose of a video interface is to link a videodisc or video cassette player directly to a microcomputer and other devices such as terminals and printers. A video interface allows the computer to control and monitor the video playback process. It enables the user to combine the power of the microcomputer with video programs to increase the effectiveness and flexibility of instruction and training.

SUBSYSTEM: CONTROL

COMPONENT: PROGRAMMER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
PROGRAMMER	Arion Corporation 825 Boone Ave. N. Minneapolis, MN 55427 Electrosonic Systems, Inc. 5223 Edina Industrial Blvd Minneapolis, MN 85335 Spindler & Sauppe Inc. 1303 N. Saticoy St. North Hollywood, CA 91605	A programmer is a multi-function, multi-channel device that is used with a tape recorder, computer or other information storage device to perform various predetermined functions. The timing of the programmer's activities is directed by a synchronizer. In addition to controlling projectors, dissolve controls and other devices, a programmer can be arranged to perform such functions (via interfaces) as operating a motorized screen, and turning on roomlights. It may contain the functions of a synchronizer and/or a dissolve control.

SUBSYSTEM: CONTROL

COMPONENT: ENCODER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
ENCODER	A.V. Services, Inc. 386 Park Ave. S. New York, NY 10016 Audio Tutorial Systems Box 4221 Mountain View, CA 94040 Electronic Designers 372 Vander Motor Pkwy Hauppauge, NY 11787	An encoder is a device that is used with a tape recorder or other information storage device to produce the synchronizing signals or pulses that will later be decoded in order to operate a combination of devices (projectors) in synchronization. An encoder, in itself, has no sychronizing ability.

SUBSYSTEM: CONTROL

COMPONENT: SYNCHRONIZER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
SYNCHRONIZER	Impact Communications 9202 Markville Dr. Dallas, TX 75243 Makenzie Laboratories 5507 Peck Road Arcadia, CA 91006	A synchronizer is a single function device which, together with a tape recorder or other type of playback equipment, operates other devices (i.e., signals for a slide change). It has only "decoding" capability (i.e., it reads a signal on playback and translates this signal into a command). Frequently built into a programmer, synchronizers tell the programmer when something is to happen and the programmer determines what happens.

SUBSYSTEM: CONTROL

COMPONENT: DISSOLVE CONTROL

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
DISSOLVE CONTROL	Arion Corporation 825 Boone Ave. N. Minneapolis, MN 55427 Electronic Systems Inc. 5223 Edina Industrial Blvd. Minneapolis, MN 55435 Simon Associates 20 Sunnyside Ave. Suite B Mill Valley, CA 94941	Dissolve controls coordinate the illumination from two or more projectors in such a fashion that the images fade from one into another at a fixed or variable rate.

SUBSYSTEM: CONTROL

COMPONENT: REMOTE CONTROL

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
REMOTE CONTROL	Audio Visual Contractors 6875 E. Evans Ave. Suite 215 Denver, CO 80224 Crestron Electronics Inc. 101 Boradway Cresskill, NJ 07626 Singer Education Systems 3750 Monroe Ave. P.O. Box 1371 Rochester, NY 14603	Remote controls are devices for controlling a machine or some function of a machine at a distance. Remote controls are frequently used with slide projectors.

SUBSYSTEM: CONTROL

COMPONENT: RANDOM ACCESS

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
RANDOM ACCESS	Audiscan Products Co. 1410 130th Ave NE PO Box 1456 Bellevue, WA. 98009 Crestron Electronics 101 Broadway Cresskill, NJ 07626 Mast Development Co. 2212 E. 12th St. Davenport, IA 52803	Random access (also called direct access) is a method by which any unit of information may be accessed directly regardless of the location of the previous piece of information retrieved. An example would be the type of slide projector on which any slide could be projected promptly by pressing a button.

SUBSYSTEM: CONTROL

COMPONENT: MULTIPLEXER

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
MULTIPLEXER	Buhl Optical 1009 Beech Ave. Pittsburgh, PA 15233 Elmo Mfg. Corp. 70 New Hyde Park Rd. New Hyde Park, NY 11040 JVC Professional Video Division US JVC Corporation 41 Slater Drive Elmwood Park, NJ 07407	Multiplexers are designed for the selective projection of 2"x2" slides, 16mm film or filmstrips into one television camera. They allow input from several different media and combine these into one video presentation.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
VECTOR GRAPHICS MONITOR	Aydin Controls 414 Commerce Drive Fort Washington, PA 19034 CPS, Incorporated 110 Wolfe Road Sunnyvale, CA 94086 Kratos, Inc. 403 S. Raymond Ave. Bin 45 Pasadena, CA 91109 Sanders Associates, Inc. Daniel Webster Hwy S. Nashua, NH 03061 Vector General, Inc. 21300 Oxnard Street Woodland Hills, CA 91367	Vector graphics are generated by using a video display tube that draws straight lines between any two points in contrast to a raster-scan display which is limited to painting a screen with closely spaced horizontal lines. Each point in a vector graphics display is expressed by a pair of numbers (x and y coordinates). The computer gives the display a stream of coordinates and beam intensities, each followed by a short delay. A line is drawn from the previous to the next point when the electron beam is on. When it is off, it moves to the next anticipated starting point. The advantages of vector graphic displays include the amount of detail possible, its speed, and the quality of its diagonal lines. The disadvantages include limited color generation and the computational drain on the microprocessor.
Monochrome Storage Displays	Princeton Electronic Products, Inc. P.O. Box 101 North Brunswick Tektronix, Inc. P.O. Box 500 Beauerton, OR 97077	Vector graphics displays are usually divided into two types: storage and refreshed displays. The distinction is based on how the image is maintained for viewing. A storage display allows phosphor, once excited, to persist for a prolonged period of time, as much as an hour. In order for a prolonged image to occur, the phosphor in the storage tube must be excited by a voltage at a certain threshhold level. Otherwise, if excited by a low intensity beam, the phosphor has short persistence. This property actually

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
Monochrome Storage Displays(Continued)		makes it possible for the storage tube to display a refreshed cursor in response to the operator's actions.
Monochrome Refreshed Displays	Aydin Controls 414 Commerce Drive Fort Washington, PA 17034	For refreshed displays, the image is maintained through repeated excitation of short-persistent phosphors. The fast response of a refreshed display is a requirement for simulated applications involving motion or for those tasks involving extensive interaction between the operator and computer.
Beam-Penetration Color Refreshed Display	CPS, Incorporated 110 Wolfe Road Sunnyvale, CA 94086 Kratos Inc. 403 South Raymond Ave. Bin 45 Pasadena, CA 91109	The beam-penetration method produces multicolor vector graphic displays. In a typical system the electron beam strikes a screen which is coated with two or more different phosphor layers. Red and green for example, would produce a display of four different colors: red, orange, yellow and green. At the lowest velocity, the beam penetrates only the first layer and that phosphor emits light of a characteristic red color. At the next higher velocity, the beam penetrates the second layer and some green light is mixed with the red to produce an orange color. The next higher level would produce yellow light and the highest level would fully penetrate the second layer to produce a predominantly green color.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
RASTER SCAN DISPLAY	California Computer Products, Inc. 2411 West La Palma Ave. P.O. Box 3250 Anaheim, CA 92803 Ramtek 2211 Lawson Lane Santa Clara, CA 95050 Tektronix, Inc. P.O. Box 4828 Portland, OR 97208	Raster scan graphics are those produced by a video display that is similar to a normal television display. In a raster scan video display, an electron beam traces horizontal lines across the face of the video display. By modulating the strength of the electron beam, the signal sent to the video display can create an image on the screen by building it up line by line. A display can be in graphic or text mode and can be color or monochrome.
Alphanumeric Display	Amdek 2201 Lively Blvd. Elk Grove Village, IL 60007	A character graphics raster display has as its smallest addressable unit a single alphanumeric character. The simplest form of character graphics systems include letters, numbers and various punctuation symbols. More sophisticated systems include a set of graphic characters used to create various shapes or forms for business or gaming purposes. Character graphics systems became popular because of their availablity, inexpensive hardware and ease of programming. The limited ability to portray curved or irregularly shaped objects is a major disadvantage. Another disadvantage is that the entire alphanumeric character must be of the same intensity or color value.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
Subcell Graphics Displays	Colorgraphic Communications Corporation Suite 105 2379 John Glenn Drive Atlanta, GA 30341 Commodore Computer Systems Group 487 Devon Park Drive Wayne, PA 19087 Intelligent Systems 225 Technology Park/ Atlanta Norcross, GA 30092	Many less expensive microcomputers utilize character subcell graphics, whereby the area normally used to portray a character is broken into an array of smaller cells that can be individually addressed (e.g., three rows by two columns).
Pixel Graphics Display	Aydin Controls 414 Commerce Drive Fort Washington, PA 19034 Data-Type 2615 Miller Ave. Mountain View, CA 94040	A pixel or "picture element" is the smallest unit of video display. When displayed in a contiguous row by column arrangement, an image is formed. Each pixel is represented in memory by one or more bits (i.e., one for monochrome, two for up to four colors, three for up to eight colors). The digital data are stored in a memorgy plane or bit map. One dimension of the array is the number of horizontal scan lines per frame and the other diemnsion is the number of pixels per line. Each pixel is an addressable point and the number of addressable points defines the display's resolution. Typical array sizes vary from 256 x 256, 512 x 256, 512 x 512, and

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
Pixel Graphics Display (continued)	Jupiter 2126 Sixth Street Berkeley, CA 94710 Lundy Electronics and Systems, Inc. Glen Head, NY 11545 Tektronix Inc. P.O. Box 4848 Portland, OR 97208	1024 x 1024. To produce the desired quality image, the resolution of the CRT must equal or graphics -- where each stored bit is mapped to a pixel on the screen -- a trade off between resolution and color palette frequently occurs because of the large memory requirements of each. Although the finer resolution displays offer the capability for a broad range of applications, including 3-D graphics, simulation, and real time operator interaction, the amount of software and memory required to manipulate the images should not be overlooked.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
INTELLIGENT COLOR RASTER SCAN DISPLAY	California Computer Products 1487 Chain Bridge Road Suite 204 McLean, VA 22101 Jupiter 2126 Sixth Street Berkeley, CA 94710 Ramtek 2211 Lawson Lane Santa Clara CA 95050 Sanders Associates Defense & Information Systems Division 95 Canal Street Nashua, NH 03061 Tektronix, Inc. 4900 S.W. Griffith Drive Beaverton, OR 97005	An intelligent color raster graphic display can be configured as either a stand-along graphics computer or a powerful terminal for use with a host computer. Basic systems include a display monitor, keyboard, serial interface to host, 68000 16-bit microprocessors with 128K bytes to 4M bytes memory. Dual pixel memory architecture provides real-time updating of screen images without blanking. Pixel data access allows direct user control of pixel data for both read and write. Typical systems have full color capability and a multiple layer information display with a 4096 selectable color palette with 8 to 256 simulataneous colors including area fill. Input and output devices are optional as is monochrome. Resolution varies by system from 512 x 512 to 2048 x 2048.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
Militarized Raster-Scan Display	Ocean Technology, Inc. 2835 North Naomi St. Burbank, CA 91504 Sanders Associates, Inc. Defense and Information Systems Division 95 Canal Street Nashua, NH 03061	The CRT displays use raster scan technology and are generally high resolution images. High contrast monitors, together with contrast enhancement and shadow masking features, and anti-glare filters serve to meet varying ambient lighting conditions. Motion and animation display capability provide for real time updating of military command and control situations, radar, or other dynamic presentations. Modular construction allows for fast and efficient field replacement. Partitioning the electronics into a few modules (typically 5 or less) has reduced terminal size, weight and interconnections while enhancing maintainability. These displays have been "ruggedized" and environmental characteristics such as high and low temperature, humidity, vibration, shock, fungus, and dust meet appropriate military standards and specifications.

SUBSYSTEM: OUTPUT COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
FLAT-PANEL PLASMA DISPLAY	Interstate Electronics Corp. Display Products Operations 1001 E. Ball Road P. O. Box 3117 Anaheim, CA 92803 Magnavox Display Systems 2131 S. Coliseum Blvd. Ft. Wayne, IN 46803	The flat-panel plasma display contains a neon and argon gas mixture sealed between two flat glass plates. The panel includes thin film x-y electrodes which form a matrix of individually addressable locations or cells. These electrodes are covered with a dielectric glass with an overcoating of magnesium oxide. Each intersection is selectively controlled to allow individual display elements to glow, forming a dot array of alphanumeric and graphic images. From a system point of view, one of the most important characteristics of the flat-panel display is its inherent memory, eliminating the need for a refresh memory to drive the display. Once a pixel has been lit, it is automatically sustained, without flicker, by a low AC voltage. Manufacturers claim a panel life of more than 20,000 operating hours. The panel, constucted of quarter-inch glass is virtually shatterproof and immune to such hazards as implosion, x-ray emissions, radioactive materials and stray magnetic fields. These characterists make plasma displays suitable for harsh field environments. "Militarized displays" have been developed to withstand water, sand, and mud. The terminal contains the same plasma display technology as described above and, in addition, incorporates a high speed 16-bit parallel microprocessor. The microprocessor

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
FLAT-PANEL PLASMA DISPLAY (continued)		controls terminal performance and provides comprehensive display capability for alphanumerics, point plots and vector graphics.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
Militarized Plasma Display	Interstate Electronics Corp. Display Products Operations 1001 E. Ball Road P.O. Box 3117 Anaheim, CA 92803	Several manufacturers offer displays for use in military and other hostile environment applications which can not be satisfied by commercial display systems. The plasma display panel has an advantage over the conventional Cathode Ray Tube (CRT) display technology. Implosion hazards and X-ray emissions are nonexistent and, unlike CRT assemblies, there are no parts subject to accidental misalignment or sensitive to harsh field environmental conditions. Several flat-panel alphanumeric and graphics display terminals are military qualified for airborne, shipboard and mobile ground systems applications. These units are completely sealed and conduction cooled and can be submerged, buried in mud and dropped by parachute. They are packaged into compact light weight rugged modules which produce bright, clear, flicker free images-easily viewed in fog, rain or bright sunlight.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
LIQUID CRYSTAL DISPLAY	Epson America Inc. 3415 Kashiwa St. Torrance, CA 90505 Panasonic Company One Panasonic Way Secaucus, NJ 07094 Quasar Company 9401 West Grand Ave. Franklin Park, IL 60131	Liquid Crystal Displays (LCD) are used primarily with the hand-held or small portable microcomputers. The most significant drawback of the LCD is its limited screen size. Originally LCDs were only one 20-40 character line. Today, the typical LCD display size is 8 lines by 40 columns--less than ideal for many users. This is a new and growing technology and the display size is constantly increasing. Larger LCDs hold promise in that they are flat and will take up less room than the conventional CRT display. Characters on the LCD screen appear in a dot-matrix format in both lower and upper cases. Most permit the scrolling of the screen to view other portions of the text. These characteristics, plus their current small size, make LCDs useful for the limited applications of hand-held computers.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
VIDEO MONITORS AND RECEIVERS	Electrohome Limited 809 Wellington St. N. Kitchener, Ontario N2G 4J6 NEC America, Inc. 1401 Estes Ave. Elk Grove Village, IL 60007 Sharp Electronics Corp. 10 Sharp Plaza PO Box 588 Paramus, NJ 07652	A video monitor is a device for reproducing the visual display of pictures from a video recorder or camera. It has no channel slector or ability to receive broadcast signals. Ordinarily, a separate sound system must be used. A video receiver has the ability to receive broadcast signals and sound capability. A typical example is a television set.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
LARGE SCREEN	General Electric Co. Projection Display Products Electronics Park 6-206 Syracuse, NY 13221 Mitsubishi International 1111 19th St. NW Washington, D.C. NEC Home Electronics, Inc. 1401 Estes Ave. Elk Grove Village, IL 60007	Large screens are used for the presentation, by a projector, of a video image. Typically these screens are several feet in dimension and are quite effective for large audiences or for viewing from a distrance. Viewing from a close angle is not recommended because of a hazy image (the further the distance, the clearer the picture). Several self contained units are commercially available with a built-in screen, projector and cabinet enclosure.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
FRONT AND REAR PROJECTION SCREENS	Audio Visual Contractors 6875 E. Evans Ave. Suite 215 Denver, CO 80224 Da-Lite Screen Co., Inc. 3100 North PO Box 137 Warsaw, IN 46580 Prosco Laboratories 36 Bush Ave. Port Chester, NY 10573	Traditional projection screens in which the image is projected to the "audience slide" of a screen are called front projection screens. Rear projection screens are often built in and consist of a translucent screen of plastic or glass with a coating on which the image is transmitted through the screen for individual or group viewing. The slide or film must be reversed by a mirror prism used to correct the image for viewing. The screen is between the projector and viewer.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
MICROFORM READER	Alan Gordon Enterprises 5362 Cahvenga Blvd. North Hollywood, CA. 91601 Dukane Corporation 2900 Dukane Dr. St. Charles, IL 60174 Revox Systems Inc. 2224 Hewlett Ave Merrick, NY 11566	A microform reader has a built-in screen or viewing glass arranged to magnify microfilm/fiche so that it can be read comfortably at normal reading distances.

SUBSYSTEM: OUTPUT

COMPONENT: AUDIO-VISUAL

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
INTERACTIVE VIDEO PLAYER	Optical Recording Project 223-5s 3M Center St. Paul, MN 55144 Pioneer Video, Inc. 200 West Grand Ave. Montvale, NJ 07645 Sony Communications Products Co. Sony Drive Park Ridge, NJ 07656	The term interactive video generally refers to the microprocessor control of a video playback device (either videotape or videodisc) which allows individuals to view one program in different ways depending upon their responses. This can be achieved by a variety of "levels" of hardware, from inexpensive random access search controllers to interactive responding systems through external microcomputers interfaced with the video player. Branching capability allows one to access a desired or needed video segment or frame. Multiple branching is a hardware/software system which allows different responses to be followed by corresponding individual segments directly related to that response. By contrast, single branching treats all incorrect responses in the same way by branching to just one catch-all segment. Interactive video has the ability to random access or search out and play segments in any order within a given program. This can be done through random access search controllers, interactive video responding and training systems or through microcomputer control.

SUBSYSTEM: OUTPUT COMPONENT: AUDIO-VISUAL

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
VIDEO TAPE PLAYER	JVC Professional Video Division US JVC Corp. 41 Slater Drive Elmwood, NJ 07407 Panasonic Industrial Co, Video Systems Division Matsushita Electric Corporation of America 1 Panasonic Way Secaucus, NJ 07094 Sony Corporation of America 9 W. 57th St. New York, NY 10019 Technicolor Audio Visual Division of Technicolor Inc. 299 Kalmus Dr. Costa Mesa, CA 92626	A video tape player reproduces recorded images and sound from a video tape (cassette, cartridge, open reel) on a video monitor or receiver. There are several different video cassette formats which are not interchangeable. These are: 3/4" U-format, 1/2" Beta, 1/2" VHS, and 1/4" CVC cassettes. Several video tape players on the market are small, portable, self-contained presentation devices with built-in screens, remote control and recording capability. These are most commonly cassette players.

SUBSYSTEM: OUTPUT

COMPONENT: AUDIO-VISUAL

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
VIDEODISC PLAYER	Discovision Associates 3300 Hyland Ave. P.O. Box 6600 Costa Mesa, CA 92626 Pioneer Video, Inc. 200 West Grand Ave. Montvale, NJ 07645 Sony Communications Products Co. Sony Drive Park Ridge, NJ 07656	There are two types of videodisc players: optical and capacitance. Optical videodisc players are the most commonly available today. Videodisc players can be connected to microcomputers through special interfaces to permit student interaction. Such configurations are referred to as interactive videodisc systems. This is a new and growing technology. Further information on the two types of videodiscs may be found under Optical Videodisc and Capacitance Videodisc. See Interactive Video Player for a discussion of interactive video systems.

SUBSYSTEM: OUTPUT

COMPONENT: AUDIO-VISUAL

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
VIDEO PROJECTOR	General Electric Co. Electronics Park Syracuse, NY 13221 Image Magnification Inc. 739 Airway Circle New Smyrna Beach, Fl. 32069 United Ventures, Inc. Tandom Division 4501 N. Route 12 PO Box 180 Richmond, IL 60071	A video projector is used to present an image from a video tape onto a video screen. Video projectors have sound capability. They are also called television projectors.

SUBSYSTEM: OUTPUT

COMPONENT: AUDIO-VISUAL

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
MOTION PICTURE PROJECTOR	Bell and Howell Company Audio Visual Products 7100 McCormick Rd. Dept. 8876 Chicago, IL 60645 Eastman Kodak Co. 343 State St. Rochester, NY 14650 Elmo Mfg. Corp. 70 New Hyde Park Rd. New Hyde Park, NY 11040 Rangerton Research Inc. 15 Roosevelt Ave. Belleville, NJ 07109	Motion picture projectors present a series of still pictures taken in rapid succession by a camera on a continuous length of film so that when projected at the same speed it produces the optical effect of a single picture in which objects move. There are several types of motion picture projectors including front screen projection in which the image is projected in a traditional method on the "audience side" of a light reflecting screen. Other types include an analysis projector which has the capability of moving film through at varying speeds so that the viewer can analyze the action or details of the image. Speeds range from normal to very slow (1 to 10 frames per second) and total stop action so that individual frames can be examined. Also, there is an interlock projector which can be interconnected with another projector or tape recorder for synchronous running. Interlock projectors are used for screening of separate picture and sound tapes or in multi-projection systems. Other interlock projectors have built in screens. Most types are available in both 8mm and 16mm formats, with and without sound.

SUBSYSTEM: OUTPUT

COMPONENT: AUDIO-VISUAL

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
FILMSTRIP PROJECTOR AND VIEWER	Audioscan Products Co. 1410 130th Ave. NE P.O. Box 1456 Bellevue, WA 98009 Radmar Inc. 1282 Old Skokie Rd. Highland Park, IL 60035	Filmstrip projectors contain a lens system which focuses a visual image from the filmstrip into a screen. Filmstrip projectors are available in both front and rear projection configurations. Some are configured for sound presentation and have random access capability. Others are used with a separate sound system such as an audio tape player or record player.
	Singer Education Systems 3750 Monroe Ave. P.O. Box 1371 Rochester, NY 14603	Filmstrip viewers allow for direct viewing of a filmstrip through the use of a backlighted image and with the aid of magnification. Due to the narrow viewing angle, film-strip viewers are more suited for individual use.

SUBSYSTEM: OUTPUT

COMPONENT: AUDIO-VISUAL

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
SLIDE PROJECTOR	Atlantic Audio Visual Corporation 630 Ninth Ave. New York, NY 10036 Bell & Howell Co. Audio Visual Products 7100 McCormick Rd. Dept. 8876 Chicago, IL 60645 Eastman Kodak Co. 343 State St. Rochester, NY 14650 MPC Educational Systems 35 Fulton St. East Haven, CT 06512	Slide projectors contain a source of light and a lens system which focuses an image from a slide, typically mounted in a cardboard or plastic frame, onto a screen. Several models of slide projectors are available. Some are equipped with a built-in rear viewing screen, others utilize a high intensity light source for projection of large images. Random access or built in advance capability is available in several models. The most common slide is 2" x 2". Slides may be contained in trays, cartridges, or drums for use in appropriately designed projectors. Slide projectors are available with and without sound capability.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
OVERHEAD PROJECTOR	Elmo Mfg. Corp. 70 New Hyde Park Rd. New Hyde Park, NY 11040 George R. Snell Assoc. Genaro Division 155 US Route 22 East Springfield, NJ 07081 Weiser/Robodyne Corp. 949 Bonifant St. Silver Spring, MD 20910	An overhead projector transmits light through a transparent acetate or frosted glass plate which lies on the surface or face of the projector. Typically, they provide projection of transparencies of up to 10" x 10" and enlarge the image on the screen. The lens and mirror arrangement in an elevated housing makes possible projection of a bright image in a relatively light room. This allows the instructor to sit or stand in front of the audience and point out items or write on the transparency.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
OPAQUE PROJECTOR	Audioscan Products Co. 1410 130th Ave. NE P.O. Box 1456 Bellevue, WA 98009 Charles Besseler Co. 8 Fernwood Rd. Florham Park, NJ 07932 Testrite Instrument Co. 135 Monroe St. Newark, NJ 07105	An opaque projector utilizes light reflection to create an image of any nontransparent object, such as printed or typed pages, drawings, maps, diagrams, photographs or flat objects in black and white or color. Typically, the screen image from an opaque projector requires a well darkened room.

SUBSYSTEM: OUTPUT

COMPONENT: VISUAL DISPLAY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
TACHISTOSCOPE	A/V Concepts Corp. 30 Montauk Blvd. Oakdale, NY 11769 Gerbrands Corp. 8 Beck Rd. Arlington, MA 02174 Lafayette Instrument Co. PO Box 5729 Lafayette, IN 47903	A tachistoscope is used for exposing a visual image for a very brief interval, typically fractions of a second. One type of tachistoscope uses a camera shutter or similar means (mechanical or electromechanical) to flash the material. Other types control the exposure by masking the presented material after the desired interval. A third method is to control the illumination of the material. Regardless of the method used, each presents controllable and intermittent timed exposures to visual material.

SUBSYSTEM: OUTPUT

COMPONENT: AUDIO

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
VOICE SYNTHESIZER MODULE	Data Voice 2 N. LaSalle Street Suite 1900 Chicago, IL 60602 Digital Pathways 1060 E. Meadow Circle Pala Alto, CA 94303 GM Enterprise, Inc. 485 E. Granville Ave. Roselle, IL 60172 MIMIC, Inc. P.O. Box 921 Acton, MA Threshold Technology 1829 Underwood Blvd. Delran, NJ 08075 Votan 4487 Technology Dr. Fremont, CA 94583	A voice synthesizer module digitizes, compresses, and stores spoken words in a vocabulary reference system. A digital code from an internal software program or external device activates the reference vocabulary. The word or phrase is digitally reproduced, converted to an analog signal, and replayed to a headset, or other external audio output unit. These systems are well suited for computer aided instruction applications that "talk an operator through" a sequence of operations. They are also used in conjunction with voice recognition in busy hands/busy eyes environments such as inspection tasks.

SUBSYSTEM: OUTPUT

COMPONENT: AUDIO

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
RECORD PLAYER	Audiotronics Corp. Video Display Div. 530 Fifth Ave. NW New Brighton, MN 55112 Califone International 5922 Bowcroft St. Los Angeles, CA 90016 Newcomb Audio Products Co. 12881 Bradley Ave. P.O. Box 4476 Sylmar, CA 91342	Record players reproduce the electronic gathering of sound on an acetate disk. They are typically used for a continuous (uninterrupted) audio presentation - frequently in conjunction with filmstrips.

SUBSYSTEM: OUTPUT

COMPONENT: AUDIO

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
AUDIO TAPE PLAYER	Ampex Corporation 401 Broadway Redwood City, CA 94063 Bell & Howell Co. Audio Visual Products 7100 McCormick Rd. Dept. 8876 Chicago, IL 60645 Telex Communications 9600 Aldrich Ave. S. Minnapolis, MN 55420	An audio tape player is a device that reproduces recorded sounds from an audio tape. The tape may be on an open reel or in a container called a cartridge or cassette. Audio tapes are commonly used with slide shows and film-strip presentations.

SUBSYSTEM: OUTPUT

COMPONENT: AUDIO

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
HEADSET	Avedex Inc. 7326 Niles Center Rd. PO Box 184 Skokie, IL 60077 Els Educational Media PO Box 20604 Oklahoma City, OK 73156 Telex Communications 7600 Aldrich Ave. S. Minneapolis, MN 55420	A headset consists of a headphone with a built-in microphone typically mounted on an adjustable boom (or arm). It is audio active, meaning that the wearer can both listen and respond to the presented material.

SUBSYSTEM: OUTPUT

COMPONENT: AUDIO

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
HEADPHONE	Audiotronics Corp. 7428 Bellaire Ave. P.O. Box 3997 North Hollywood, CA 91609 P/H Electronics Inc. 413 E. Helena St. Dayton, OH 45404 Wollensak/3M Co. 3M Center Bldg. 225-3NE St. Paul, MN 55144	A headphone is a device consisting of one or two electro-acoustic receivers attached to a headband for individual listening to the audio source (also called earphones). A headphone is an audio-passive, listen only device.

SUBSYSTEM: OUTPUT

COMPONENT: HARD COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
DOT MATRIX IMPACT PRINTER	Centronix Data Computer 1 Wall Street Hudson, NH 03051 Data South Computer Corp. P.O. Box 240947 Charlotte, NC 28224 Digital Equipment Corp. Maynard, MA 01754 Texas Instruments Digital Systems Group P.O. Box 1444,M/S 7793	Dot matrix printers have a printhead grid consisting of dots in columns and rows. Tiny hammers are activated to print a dot only where appropriate to form each letter. Five columns by seven rows is acceptable resolution for many purposes; denser grids, such as 7x9 and 16x35, provide higher resolution. Dot matrix printers generally are not appropriate for letter quality application; however, rapid operation and inexpensive price account for their appeal.

SUBSYSTEM: OUTPUT

COMPONENT: HARD COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
MULTI-MODE DOT MATRIX PRINTER	Axiom Corporation 1014 Griswold Avenue San Francisco, CA 91340 Qantex 60 Plant Avenue Happauge, NY 11788 Printek, Inc. 1517 Townline Rd. Benton Harbor, MI 49022	More expensive higher resolution dot matrix printers are becoming increasingly popular for complex graphics work. These printers are pin addressable and capable of letter quality type in various fonts.

SUBSYSTEM: OUTPUT COMPONENT: HARD COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
DAISY-WHEEL IMPACT PRINTER	Cromemco, Inc. 280 Bernardo Ave. Mountain View, CA 94040 Diablo Systems Inc. P.O. Box 5003 Hayward, CA 94545 Dynax 333 South Hope St. Suite 2800 Los Angeles, CA 90071 Epson America, Inc. 3415 Kashiwa Street Torrance, CA NEC Information Systems 5 Militia Drive Lexintton, MA 02173 Qume 2350 Qume Drive San Jose, CA 95131 SYSTEMED Corp. JCMH Hospital Drive Mountain City, TN 37683	Impact printers leave a printed character by striking the paper. Daisy-wheel printers consist of a plastic wheel with spokes radiating out from a center; alphanumeric characters and symbols are at the end of each spoke. After the appropriate spoke is rotated into place, an electromagnetic hammer strikes the spoke, driving it against the ribbon and paper. Daisy-wheel printers produce letter quality printed text.

SUBSYSTEM: OUTPUT

COMPONENT: HARD COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
INK-JET PRINTER	Exxon Office Systems P. O. Box 10184 Stamford, CT 06904	Ink-jet printers use precision jets to direct ink on paper in a dot-matrix pattern. The letter quality of ink-jet printers is very good; many have color graphic capability. Ink-jet printers are quiet and print at speeds up to 90 characters per second.

SUBSYSTEM: OUTPUT

COMPONENT: HARD COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
THERMAL PRINTER	Alphacom, Inc. 2323 So. Boston Avenue Campbell, CA 95008 Hewlett-Packard 1010 NE Circle Blvd. Corvallis, OR 97330	Thermal printers use small heat elements in a dot pattern to place marks on special paper. These printers provide high throughput, quiet operation and are usually inexpensive.

SUBSYSTEM: OUTPUT

COMPONENT: HARD COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
FLATBED PLOTTER	Bausch and Lomb Instruments and Systems Division POB 15720 Autsin, TX 78761 CALCOMP 2411 W. La Palma Ave. P.O. Box 3250 Anaheim, CA 92803 Xynetics, Inc. 2901 Coronado Dr. Santa Clara, CA 95051	A flatbed plotter moves a pen carriage in x-y directions over a flat surface where paper is held in place by an electrostatic charge. An electric motor controls x-y movement direction that enables the pen to draw a series of miniature line segments capable of approximating smooth curves. Plotting time is dependent on the start/stop speed of the motors and how fast the pen can move across the paper. The plotter's microcomputer converts program instructions to pen movements and generates the timed signals for the motor's control of pen movements. Flatbed plotters have the advantage of using multiple pens to create multiple color drawings.

SUBSYSTEM: OUTPUT

COMPONENT: HARD COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
DRUM PLOTTER	Strobe Inc. 897-5A Independence Ave. Mountain View, CA 94043 Houston Instrument 8500 Cameron Road Austin, TX 78753	On a drum plotter, the paper is fed by a sprocket-mechanism on a roller. During plotting operations, the paper rotates along the roller and the pen moves in a straight bidirectional line above the roller. Compared to comparable flatbed plotters, drum plotters occupy less space.

SUBSYSTEM: OUTPUT

COMPONENT: HARD COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
ELECTROSTATIC PLOTTER (Photoconductive Plate Method)	Versatec 2805 Bowers Avenue Santa Clara, CA 95051	The graphic image is first produced on an internal CRT, the visible light of which is transformed by a photoconductive plate into a charge on a paper. Upon exposure completion, toning and drying is applied to the entire page of output. New versions of electrostatic plotters employ a laser beam instead of a CRT electron beam to form the image. Full *color output is possible by combining several pigments.*
(Matrix-Writing Technique)	Gould, Inc. Instruments Division 3631 Perkins Ave. Cleveland, OH 44114	To create a visible image, a static electric charge is applied to the area of the paper to be plotted. A liquid carbon toner is applied which clings to the charged area and quickly dries. The plot consists of a pattern of block dots, resulting from the charge placed on the paper by a bar containing thousands of stationary writing needles. The computer determines the needles to which to apply voltage. As an entire line is plotted with appropriate dots, the paper advances, the sequence is repeated until the complete image is formed. The simple construction of a matrix plotter has only a few moving parts: those for advancing the paper and drying the toner. Matrix writing produces a sharp black on white image. Straight vertical and horizontal lines appear solid, but diagonal and curved lines have stairstep appearance. The plotter's standard character set produces text efficiently in 7x9 or 16x16 dot formats.

SUBSYSTEM: OUTPUT

COMPONENT: HARD COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
GRAPHIC FILM RECORDER	California Computer Products 2411 W. La Plama Anaheim, CA 92801 Discomed Corporation 9700 Newton Avenue S. Minneapolis, MN 55431	Also known as photoplotters, graphic film recorders basically take photographs of images from an internal CRT. The CRT is timed coordinated with the film transport to allow movement for each single line scan, until enough scans have been produced for the entire image. Color photoplotting is possible by transmitting white light from the CRT through a color filter assembly.

SUBSYSTEM: OUTPUT

COMPONENT: HARD-COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
HARD COPY UNIT	Seiko Instruments Graphic Devices and Systems Division 2620 Augustine Dr. Suite 140 Santa Clara, CA 95051	Hard copy devices provide high resolution, color copies of a video image. The desired video image is down-loaded to the copier and stored in the copier's local memory thus freeing the computer terminal for continued operation while the hard copy is being generated. Several number of copies (typically 1-99) can be produced from the image stored in the copier's memory. An advanced thermal ink technology superimposes dots of the primary colors on the paper which when heated result in a color copy.

SUBSYSTEM: OUTPUT

COMPONENT: HARD COPY

COMPONENT TYPE	REPRESENTATIVE VENDORS	FUNCTIONAL DESCRIPTION
MICROFORM READER/ PRINTER	Alan Gordon Enterprises 5362 Cahvenga Blvd. North Hollywood, Ca. 91601 Dukane Corporation 2900 Dukane Dr. St. Charles, IL 60174 Revox Systems, Inc. 2224 Hewlett Ave. Merrick, NY 11566	A microform reader which has built-in equipment to produce a paper copy at a size equivalent to the original. Microform reader/printers are configured for either microfilm or microfiche.

APPENDIX D

CRITERIA FOR SELECTING CANDIDATE COMPONENTS

APPENDIX D

CRITERIA FOR SELECTING CANDIDATE COMPONENTS

INPUT SUBSYSTEM	SELECTION CRITERIA	SELECTED COMPONENTS
Keyboard Specialized Capacitive Keypad Digitizers • Touch-Sensitive • Electromagnetic • Sonic • Light Detector Joystick • Displacement • Force-Operated • Switch-Activated Trackball Dial Thumb Wheels Mechanical Mouse Optical Mouse The Depraz Mouse Voice Entry Unit	Qualitatively different components varying with respect to: 1) Ease of use 2) Accuracy of control 3) Speed of interaction	Keyboard Specialized Capacitive Keypad Light Pen Touch-Sensitive Digitizer Joystick Mouse Voice Entry Unit

STORAGE SUBSYSTEM	SELECTION CRITERIA	SELECTED COMPONENTS
Cassette Tape ¼" Data Cartridge Tape Floppy Disk Winchester Hard Disk Bubble Memory Capacitance Videodisc Optical Videodisc	Consideration of mass storage components that vary with respect to: 1) Storage capacity 2) Speed 3) Cost 4) Endurance	Cassette Tape ¼" Data Cartridge Tape Floppy Disk Winchester Hard Disk Optical Videodisc

CONTROL SUBSYSTEM (PROCESSING)	SELECTION CRITERIA	SELECTED COMPONENTS
Hand-Held Computer (Dedicated Bus) Desktop Microcomputer (Dedicated Bus) 8-bit Microcomputer 16-bit Microcomputer Multiple Microprocessors	Consideration of qualitatively different control (or processing) components varying with respect to: 1) Memory capability 2) Speed of operation 3) Power 4) Portability	Hand-Held Computer (Dedicated Bus) Desktop Microcomputer (Dedicated Bus) 8-bit Microcomputer 16-bit Microcomputer Multiple Microprocessors

OUTPUT SUBSYSTEM (VISUAL DISPLAY)	SELECTION CRITERIA	SELECTED COMPONENTS
Vector Graphics Monitor Raster-Scan Display • Alphanumeric • Subcell graphics • Low resolution pixel • Medium resolution pixel • High resolution pixel Intelligent Raster-Scan Display Flat-Panel Plasma Display Liquid Crystal Display	Consideration of output (visual display) components that vary with respect to: 1) Speed 2) Color generation 3) Resolution 4) Computational Drain 5) Intelligence 6) Portability	Raster-Scan Display Intelligent Raster-Scan Display Flat-Panel Plasma Display Liquid Crystal Display

OUTPUT SUBSYSTEM (AUDIO)	SELECTION CRITERIA	SELECTED COMPONENTS
Voice Synthesizer Module Reconstructed Voice Recorded Voice	Consideration of audio output devices that will allow for: 1) Voice response	Voice Synthesizer Reconstructed Voice Recorded Voice

OUTPUT SUBSYSTEM (HARD-COPY)	SELECTION CRITERIA	SELECTED COMPONENTS
Dot-Matrix Impact Printer Multi-Mode Dot Matrix Printer Daisy-Wheel Impact Printer Ink-Jet Printer Thermal Printer Flatbed Plotter Drum Plotter Electrostatic Plotter Graphic Film Recorder Hard Copy Unit	Consideration of hard-copy output devices that vary with respect to: 1) Quality 2) Speed 3) Noise 4) Color capability 5) Graphics capability 6) Space Requirements	Dot-Matrix Impact Printer Multi-Mode Matrix Printer Ink-Jet Printer Thermal Printer Flatbed Plotter Electrostatic Plotter Hard Copy Unit